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Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

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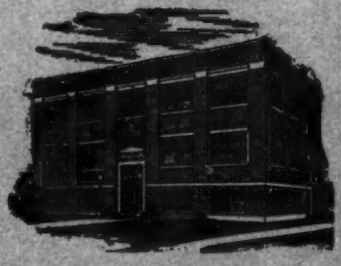

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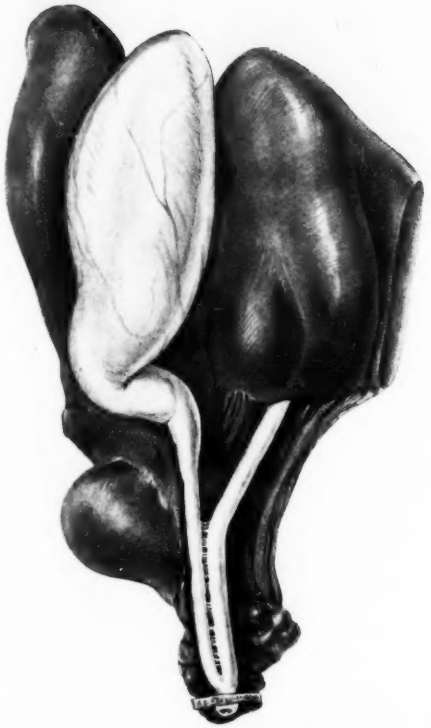

Fig. 21. Specimen showing long parallel mode of union of cystic and hepatic ducts. They pursue a parallel course until one-half centimeter above the ampulla.

Fig. 23. Specimen showing anterior spiral mode of union of cystic and hepatic ducts. Note the loop formed by the main hepatic duct. The cystic duct crosses the front of the main hepatic duct to enter its left side. The cystic artery lies to the left side of the main hepatic duct and crosses in front of it to reach the gall-bladder.

(Operative Injury of the Common and Hepatic Bile-Ducts.—Daniel N. Eisendrath.)

SURGERY, GYNECOLOGY AND OBSTETRICS

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OPERATIVE INJURY OF THE COMMON AND HEPATIC BILE-DUCTS[1]

BY DANIEL N. EISENDRATH, A.B., M.D., F.A.C.S., CHICAGO

ATTENTION was called in a previous article[2] to the importance of a more widespread knowledge of the variations from the normal of the distribution of the blood-vessels of the biliary region as well as the unusual modes of union of the bile-ducts. Although my own investigations were entirely in the direction of the study of the variations in the mode of union of the cystic and hepatic ducts, further examination of the dissections revealed the fact that they presented nearly every form of vascular anomaly which had been described by Rio Branco and Descomps. I have, therefore, had drawings made of these specimens because they convey a better conception of the actual conditions found at operation than any diagrams.

The object of the present paper is two-fold: first, to present these anomalies of the ducts and vessels as found in my own specimens (Figs. 12 to 24), and second, to show by a tabulation of a series of 51 case reports (50 from the literature and personal communications) including one of my own, that accidents during operations on the bile-ducts are not infrequently due to such anomalies.

The investigations of Rio Branco and Descomps on the anomalies of the blood-vessels of the biliary region and of Ruge, Kunze, Descomps, Behrend, and myself on the bile-ducts show that the surgeon who wishes to minimize the chances of such accidents must be familiar with the following observations:

1. The standard textbooks of anatomy do not mention the variations which are of such importance to the surgeon. The cystic artery is described as a single vessel arising from the right hepatic (Fig. 1) shortly after the latter passes behind the main hepatic duct. Again the mode of union of the cystic and hepatic ducts is stated as being always of the acute angular type. No mention at all is made of the plexus of veins and arterioles which lie on the surface of the common duct (Fig. 1) and cause an obstinate hæmorrhage if overlooked.

2. The right hepatic artery varies greatly in its relations to the main hepatic and cystic ducts (Figs. 2, 13, 14).

3. The variations in the course of the gastroduodenal artery and of one of its chief branches, the pancreaticoduodenal, must be borne in mind in operations on the common duct (Figs. 3 and 16).

4. The cystic artery does not always arise from the right hepatic artery after the latter crosses the right edge of the main hepatic duct (Figs. 4 and 17).

5. There is a single cystic artery in only 88 per cent of individuals instead of in 100 per cent as is generally taught. Even when single, the cystic artery does not always arise from the right hepatic (Fig. 5). An overlooked cystic artery arising from the gastroduodenal

[2] J. Am. M. Ass., 1918, lxxi, 864.

[1] Read before the Chicago Surgical Society, May 7, 1920.

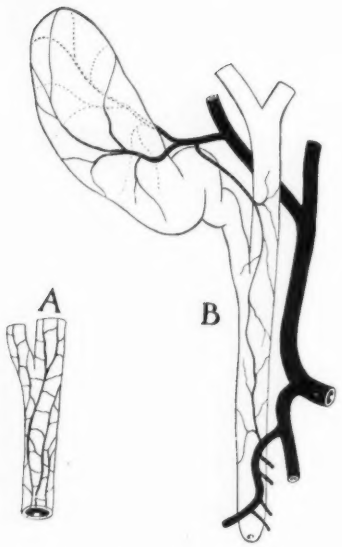

Fig. 1. Blood supply of gall-bladder and extrahepatic bile-ducts and mode of union of latter as described in the standard textbooks of anatomy. *A*. Plexus of veins on surface of common duct. *B*. Angular mode of union of cystic and hepatic ducts to form the common duct. Cystic artery arises from right hepatic and enters gall-bladder at its neck, dividing into two branches at this point. Cystic artery distributes small branches which anastomose on the surface of common duct, with the branches of the pancreatic-duodenal artery. Note how right hepatic artery passes behind main hepatic duct before giving off cystic artery.

(Figs. 5 and 18) may cause severe bleeding when accidentally divided.

6. In 12 per cent of individuals there are two cystic arteries, both of which do not always arise from the right hepatic (Fig. 6). In my own case (Group 4), after one cystic artery had been ligated during cholecystectomy, severe bleeding occurred from an overlooked second cystic artery. The hepatic duct was included in the grasp of the forceps while attempting to control the hæmorrhage from the stump of a retracted second vessel (Fig. 26).

7. In only 75 per cent of individuals do the cystic and hepatic ducts unite at an acute angle. When this does occur the terminal 2 centimeters are firmly held together by fibrous tissue (Fig. 7). In 17 per cent, the ducts pursue a parallel course before they unite (Figs. 7, 19, 20, and 21). The latter may not take place until ½ to 1 centimeter above the ampulla. In 8 per cent, the cystic duct makes a spiral twist around the front (Figs. 7, 22, and 23) or the back (Figs. 7 and 24) of the main hepatic duct before they unite to form the common duct. The clinical possibilities of such variations are well shown in Figure 8.

8. Anomalies in the hepatic and common ducts may be found (a) as variations in the mode of union of the right and left hepatic ducts before the main hepatic duct is formed (Fig. 9), or (b) as accessory hepatic ducts (Fig. 10), or finally (c) as a double common duct (Fig. 11).

Before I take up the question as to how accidents due to the presence of any of the anomalies just described can be avoided, it may be of interest to survey the injuries to the ducts which have been reported up to the time of writing this paper.

J. H. Jacobson[1] collected all of the cases reported up to 1916 and Ellsworth Eliot[2] all of those published to 1918.

I did not feel satisfied that all of the cases included in both of these reports were due to injury, hence careful examination of all of the individual contributions was undertaken. A number of these case reports when examined in the original proved the injuries to be lacerations or strictures of the ducts which had occurred as the result of pathological changes incident to the biliary infection.

Excluding such cases I have been able to collect 51 injuries of the bile-ducts due either to errors in technique or to anatomical variations. Thirty-three of the case reports are included in the papers of Jacobson and Eliot. Eighteen additional cases have been added from three sources: (a) from publications which have appeared since those of the above-mentioned authors, (b) from personal communications, and (c) a report of a personal case.

I have divided the 51 cases into 4 groups:

1. Those in which the injury was recognized at the time of the operation or shortly thereafter and immediate repair instituted. The majority of cases (26) belong in this group.

[1] Am. J. Obst., 1916, lxx, 948.
[2] Surg., Gynec. & Obst., 1918, xxvi, 81.

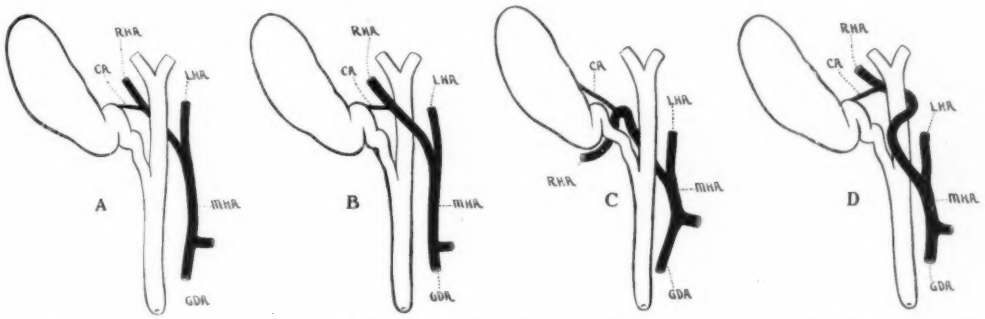

Fig. 2. Relations of the right hepatic artery to the main hepatic duct. *A*, In 70 per cent the right hepatic artery runs behind the main hepatic duct and the cystic artery arises just beyond the right edge of the duct. *B*, In 12 per cent the right hepatic artery passes across the front of the main hepatic duct before entering the right lobe of the liver. *C*, In 10 per cent the right hepatic artery runs parallel to the cystic duct throughout its course and lies in close proximity to the neck of the gall-bladder before entering right lobe of liver. Artery could be easily injured during cholecystectomy. *D*, In 8 per cent the right hepatic artery crosses the right edge of the main hepatic duct and then enters liver or forms a ring around hepatic duct.

The abbreviations employed are identical in Figures 2, 3, 4, and 5. *mha*, Main hepatic artery; *lha*, left hepatic artery; *rha*, right hepatic artery; *ca*, single cystic artery; *gda*, gastroduodenal artery; *pda*, pancreaticoduodenal artery; *sca*, second cystic artery.

2. Those in which an immediate or early repair of the injury was not successful so that a secondary operation was necessary. There were 4 cases in this group.

3. The injury was overlooked at the time of the primary operation so that only a secondary operation (usually for a stricture) was performed. There were 14 cases in this group.

4. In the last group are included miscellaneous cases as described in the footnote under Group 4.

Analysis of the 51 cases reveals the fact that there are 5 modes of injury as follows:

1. A resection of the junction of the cystic, hepatic, and common ducts (12 cases). This often results from the angulation incident to traction during cholecystectomy (*C* in Fig. 25), especially when a clamp is applied to the cystic duct. The defect remaining after such an excision of the angle of junction of the three ducts is shown in *D* of Figure 25.

2. Tear, ligation, or division of the main hepatic duct during cholecystectomy (19 cases). This injury may occur (a) during separation of the pelvis (whether on the upper or lower side) of the gall-bladder (*A* and *B* of Fig. 25) from the common or hepatic ducts,

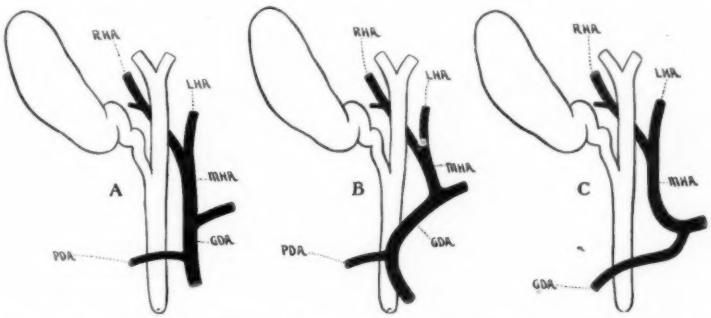

Fig. 3. Variations of the gastroduodenal artery in relation to the common duct. *A*, In 76 per cent a branch of the gastroduodenal artery crosses the common duct. *B*, In 38 per cent the gastroduodenal artery arches across the left border of the common duct. *C*, In 20 per cent the gastroduodenal artery itself passes across the front of the common duct.

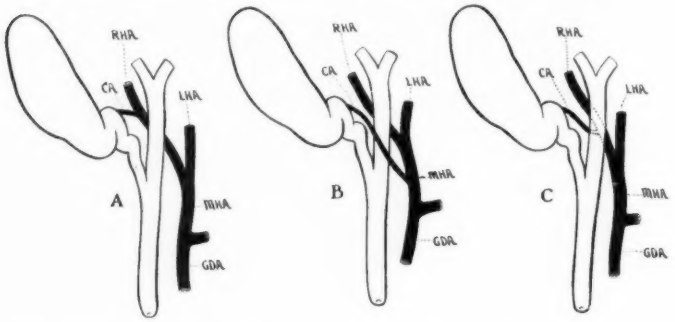

Fig. 4. Relation of the single cystic artery to the main hepatic ducts. *A*, In 71 per cent the cystic artery arises to the right of the main hepatic duct. *B*, In 27 per cent the cystic artery arises on the left side of the hepatic or common ducts and must cross one of these to reach the neck of the gall-bladder. *C*, In 2 per cent the cystic artery arises behind the main hepatic duct and if it should retract it is easy to include the duct in the grasp of the forceps.

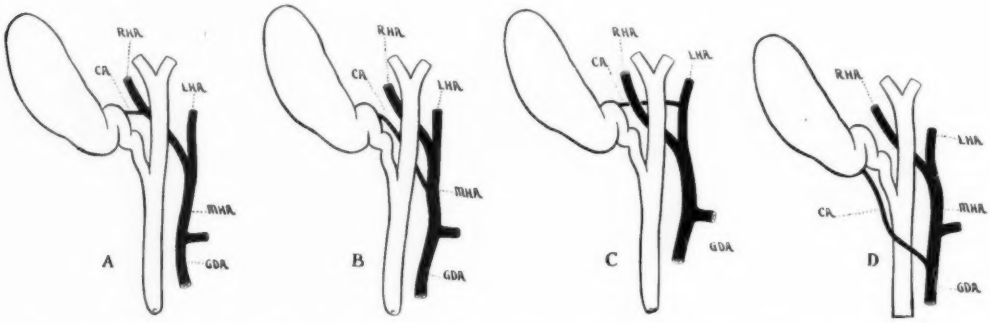

Fig. 5. Anomalies in the origin of the single cystic artery. *A*, There is only one cystic artery in 88 per cent of individuals. In 82 per cent of these it arises from the right hepatic artery. *B*, In 3 per cent of the 88 per cent the cystic artery arises from the main hepatic. *C*, In 2 per cent of the 88 per cent the cystic artery arises from the left hepatic. *D*, In 1 per cent of the 88 per cent, the cystic artery arises from the gastroduodenal artery. This is a very important anomaly if the artery is looked for only in usual place, i.e. arising from right hepatic.

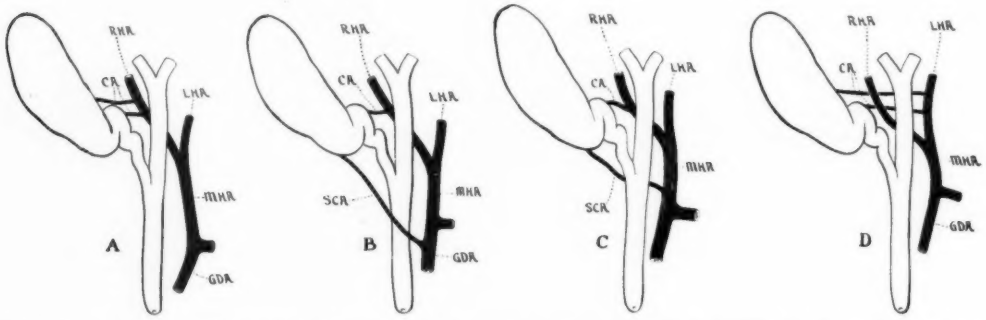

Fig. 6. Various modes of origin of double cystic arteries. *A*, In 8 per cent of the cases having two cystic arteries, both vessels (*ca*) arise from the right hepatic artery. *B*, In 2 per cent one artery arises from the right hepatic and the other (*sca*) from the gastroduodenal artery. *C*, In 1 per cent one artery arises from right hepatic and the other (*sca*) from the main hepatic (hepatica propria) artery. *D*, In 1 per cent both vessels arise from right hepatic artery.

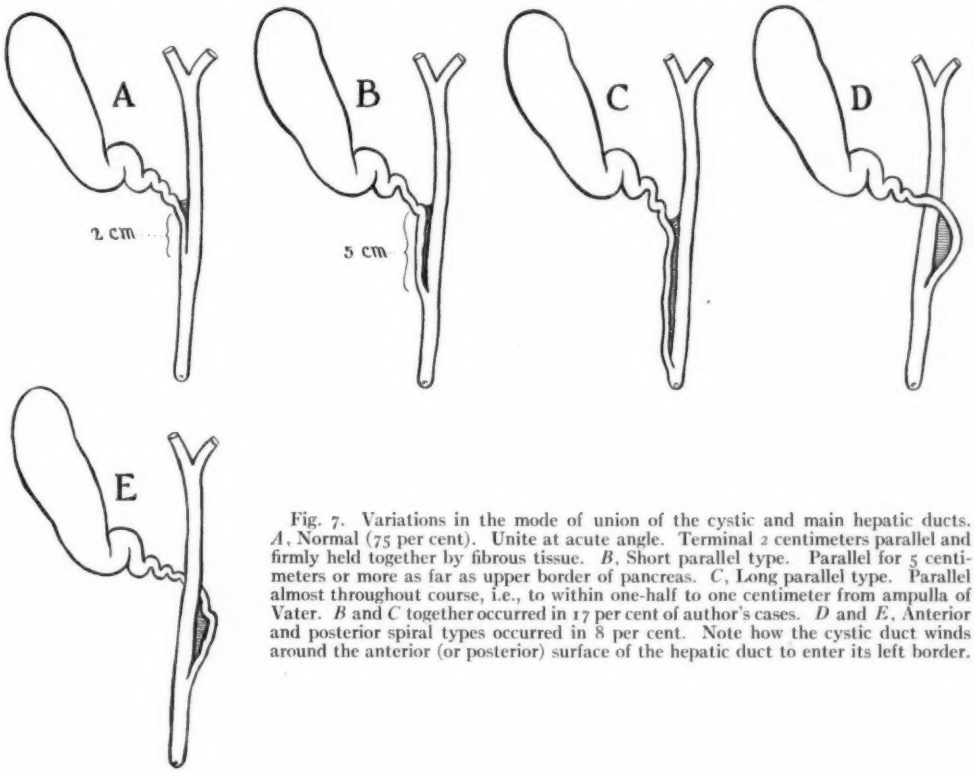

Fig. 7. Variations in the mode of union of the cystic and main hepatic ducts. *A*, Normal (75 per cent). Unite at acute angle. Terminal 2 centimeters parallel and firmly held together by fibrous tissue. *B*, Short parallel type. Parallel for 5 centimeters or more as far as upper border of pancreas. *C*, Long parallel type. Parallel almost throughout course, i.e., to within one-half to one centimeter from ampulla of Vater. *B* and *C* together occurred in 17 per cent of author's cases. *D* and *E*, Anterior and posterior spiral types occurred in 8 per cent. Note how the cystic duct winds around the anterior (or posterior) surface of the hepatic duct to enter its left border.

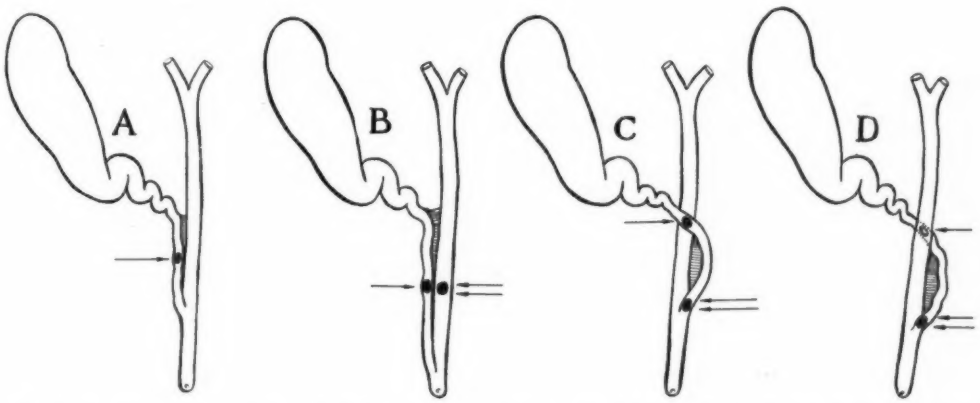

Fig. 8. Possible locations of the calculi in cases with anomalies of the mode of union of the cystic and hepatic ducts. *A*, Calculus in cystic duct of short parallel type can compress hepatic duct and cause same symptoms as calculus in that duct. *B*, Calculi in long parallel type of ducts. Could cause great technical difficulty in removal with possible injury of ducts. *C*, Calculi in spiral cystic duct. Very puzzling clinical picture if one (single arrow) compresses hepatic duct and other obstructed a cystic duct (double arrow) emptying into hepatic duct on its left side. *D*, Similar possibilities in posterior spiral type from clinical and operative standpoint as in *C*.

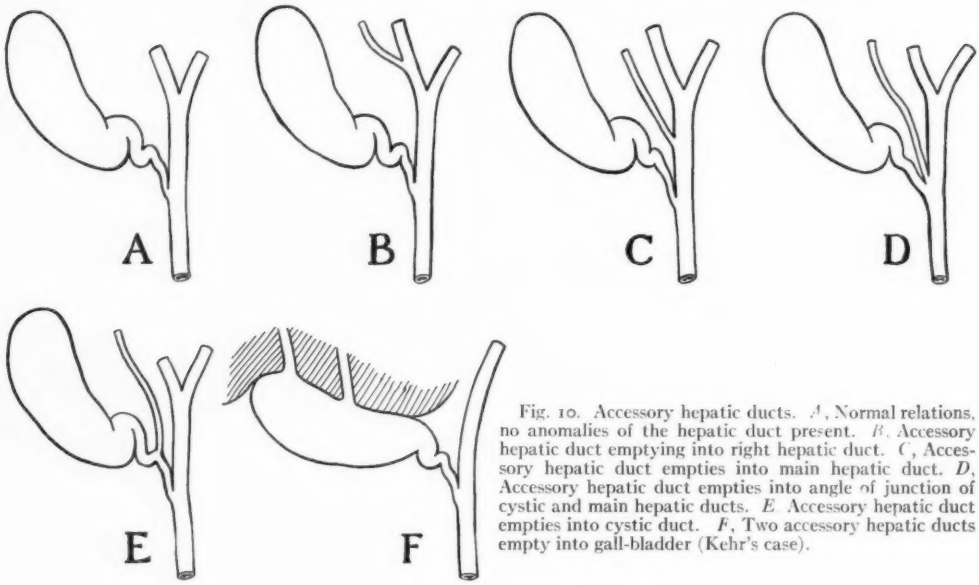

Fig. 10. Accessory hepatic ducts. *A*, Normal relations, no anomalies of the hepatic duct present. *B*, Accessory hepatic duct emptying into right hepatic duct. *C*, Accessory hepatic duct empties into main hepatic duct. *D*, Accessory hepatic duct empties into angle of junction of cystic and main hepatic ducts. *E* Accessory hepatic duct empties into cystic duct. *F*, Two accessory hepatic ducts empty into gall-bladder (Kehr's case).

or (b) when the cystic duct is very short or much dilated (*E* and *F* of Fig. 25), or (c) when the cystic and hepatic ducts are parallel (*A* in Fig. 27) or the cystic duct winds around the main hepatic duct (*B* in Fig. 27).

3. Common duct resected (16 cases). This may occur in one of the ways described under 1 and 2 or the duct may be included in a clamp, resected or divided during cholecystectomy or it may be torn during a choledochotomy.

4. Anomalies of the hepatic duct (1 case). This case was reported by Kehr. The right hepatic duct emptied into the cystic duct and was included in the clamp applied to the cystic duct.

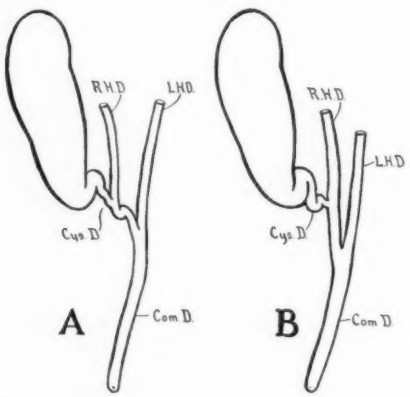

Fig. 9. Anomalies of the right hepatic duct. *A*, Right hepatic duct (*rhd*) empties into the cystic duct (*cys.d*). *B*, Cystic duct empties into the right hepatic duct (*rhd*). *Lhd*. Left hepatic duct. *Com.d*. Common duct.

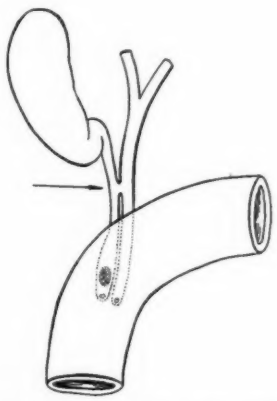

Fig. 11. Double common duct. Note calculus lying in one of two parallel common ducts. There is a communication between the cystic and the main hepatic ducts (Kehr's case).

Fig. 12. Specimen showing normal angular mode of union of cystic and hepatic ducts. Note parallelism for last 2 centimeters of these two ducts. The common duct is almost entirely surrounded by pancreas.

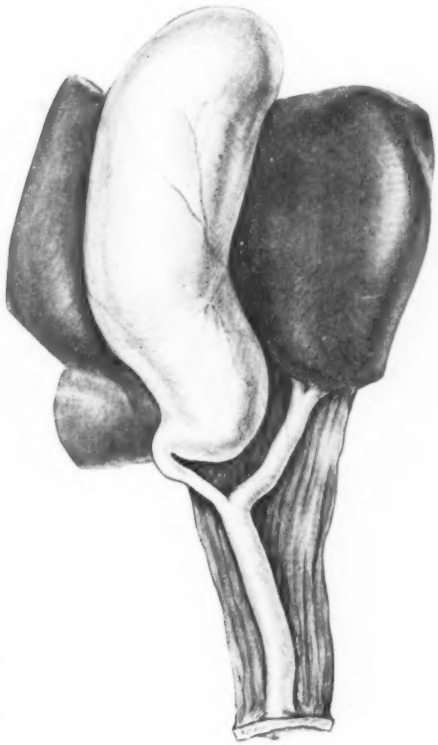

Fig. 13. Specimen showing extremely short cystic duct and pelvis of the gall-bladder on its upper side (reversed ampulla or pelvis).

5. Main hepatic or common ducts ligated or resected during effort to grasp the bleeding stump of a single cystic artery (*A* of Fig. 26), or an overlooked single cystic artery having an anomalous origin (*B* of Fig. 26) or a second cystic artery (*C* in Fig. 26) as in the writers' case (Group 4, Case 7). There were 3 cases which can be placed under the head of this mode of injury.

IMMEDIATE AND REMOTE EFFECTS

The immediate mortality in the 51 cases was comparatively slight, i.e. only 3, two of pneumonia and one of cholæmia. The late mortality was also small, only one death from cholangeitis, 7 months after the primary operation.

There were 42 apparently complete recoveries following operative measures. No end-results are given in the reports of 5 cases.

METHODS OF REPAIR

I have attempted to show in Figures 28 and 29, the most frequently employed methods of repair. These varied, of course, according to the time at which the case was first seen, according to the length of the gap or defect, and according to whether it was possible to utilize the distal portion of the common duct.

The ideal procedure, and one only applicable as a rule to recent cases, is circular suture of the divided ends (*A* of Fig. 28). At times

Fig. 14. Specimen showing normal angular mode of union of cystic and hepatic ducts. The main feature of the specimen is that the right hepatic artery is at first parallel to the cystic duct, then passes close to the neck of the gall-bladder, and enters the right lobe of the liver. This anomaly is of great importance in connection with possible injury of the artery during cholecystectomy.

only a portion, usually the posterior half, can be approximated. The methods of end-to-end anastomosis with the aid of a rubber tube allowed to emerge through a separate opening in the duct (*B* of Fig. 28) or through the ampulla of Vater, i.e. into the duodenum

Fig. 15. Specimen showing how right hepatic artery forms a loop in front of hepatic duct.

(*C* of Fig. 28) rank second in the choice of methods.

Reconstruction of the hepatic or common ducts over a rubber tube with the aid of omentum (*D* of Fig. 28) is preferable in cases where there is a gap between the ends. The use of fascia or of a vein to bridge the gap has never been accepted as a suitable substitute for omentum.

End-to-end anastomosis over a rubber tube allowed to emerge through a separate opening in the duodenum (the transduodenal drainage method of Voelcker) has been employed in too few cases to serve as a guide for its future use. The resection of a stricture or even the existence of a large defect in the primary operation may call for some form of anastomosis. Those most often used are the implantation of the proximal end of the hepatic duct by the Witzel or Coffey method

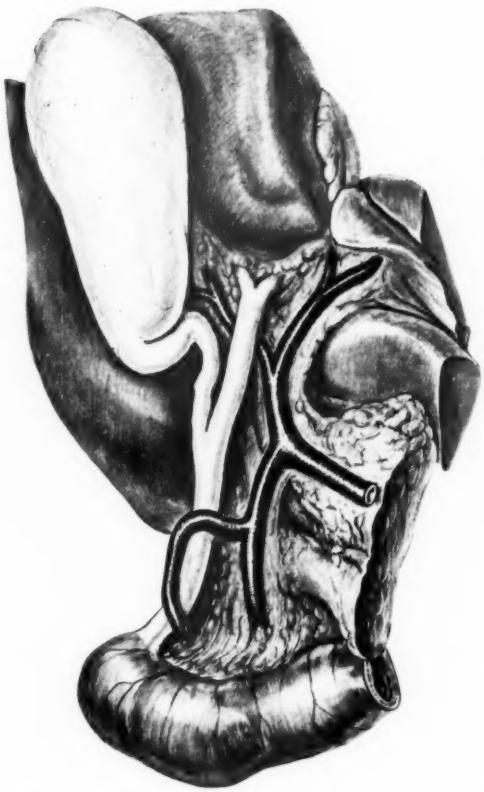

Fig. 16. Specimen showing the superior pancreaticoduodenal artery crossing the common duct.

into the duodenum (*A* of Fig. 29) or rarely into the jejunum with the aid of a rubber catheter as in Nordmann's case (*B* of Fig. 29).

The closure of the defect by the use of a flap composed of the stump of the cystic duct (Case 16, Group 1), or with a flap from the stomach wall (Case 17, Group 1) and similar plastic methods are so seldom applicable as to require only a brief mention.

HOW TO AVOID INJURIES OF THE BILE-DUCTS DURING OPERATIONS

Any operator of large experience will agree with the writer that the pathological changes in many cases render it very difficult to avoid accidents. The operative field even under most favorable conditions is a limited one,

Fig. 17. Specimen showing the cystic artery arising on the left side of the main hepatic duct and crossing latter to reach the neck of the gall-bladder.

and important structures lie in such close proximity that it is not surprising to read of the accidents just cited. One must remember that in all probability these 51 cases do not represent all of the accidents which have occurred. Many surgeons feel that such sequelæ are the result of faulty technique and do not publish their bad results. Although it is difficult to state with any degree of certainty as to how many of the reported accidents have been due to anomalies of the bile-ducts or blood-vessels, yet I feel confident that a sufficiently large number are due to these variations from the normal, as to make it imperative that every surgeon be thoroughly familiar with them. Kehr believed that a relatively high percentage of his accidents (15 in his first 1,000 cases) were due to such anomalies. I do not know how often these cases have been found in such a large series of operations on the bile passages as have been performed at the Mayo Clinic, but no doubt some publication to elucidate this

Fig. 18. Specimen showing the cystic artery arising from the gastroduodenal and crossing the common duct obliquely to reach the lower side of the gall-bladder.

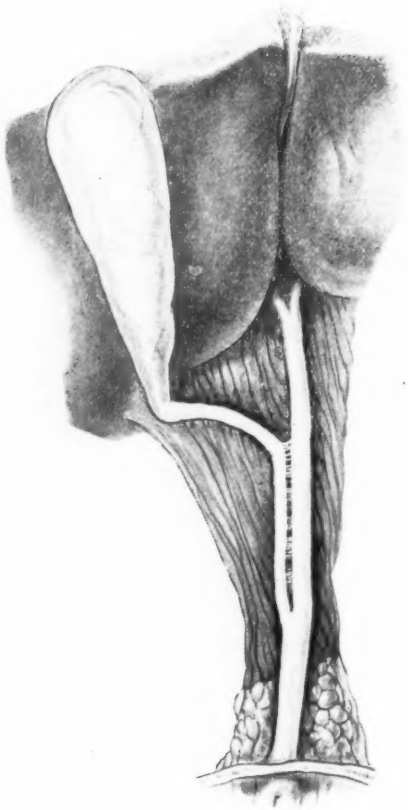

Fig. 19. Specimen showing short parallel mode of union of cystic and hepatic ducts. Note how firmly they are bound together by strands of fibrous tissue.

feature will appear in the near future from this and other clinics with a large materia!.

I have found that the following precautions greatly minimize the chances of accidents during cholecystectomy or choledochotomy and can warmly recommend them. They are the result of the development of a technique based partly on a relatively large operative experience and partly upon the study of a number of dissections of this region by the investigators quoted at the beginning of this article.

1. The incision should be so placed that an adequate exposure of the structures from the duodenum to the liver is obtained. The incision which I believe was first suggested by Kehr adequately fulfills the above requirements. It extends from the ensiform to the umbilicus through the inner third of the right rectus muscle, thus exposing at once (especially if a table with an elevator for the gall-bladder region is used) the common duct and the structures adjacent thereto.

2. If cholecystectomy is decided upon, one can avoid the danger of encountering anomalies of the ducts and vessels in the majority of cases by an incision through the anterior leaf of the hepatoduodenal ligament and identification of the underlying supraduodenal portion of the common duct as our first landmark.

3. Care having been exercised not to injure any of the fine veins or arteries lying on the

Fig. 20. Specimen showing long parallel course of cystic and hepatic ducts. The two become united close to the ampulla and are bound together by strands of fibrous tissue.

surface of the common duct (Fig. 1), the next step is to separate the pelvis or ampulla of the gall-bladder (as first emphasized by W. J. Mayo) from the common duct.

4. The third step exposes the cystic duct and artery, main hepatic and common duct.

All of the steps of the operation thus far outlined are greatly facilitated by rotating the right lobe of the liver outward (Mayo-Robson grip), and making traction upon the fundus and later upon the ampulla of the gall-bladder. If the latter is tensely filled with calculi and liquid contents, the future steps are rendered far easier if the calculi and liquids are removed. My choice of technique is to begin at the neck as just outlined because

Fig. 22. Anterior spiral mode of union of cystic and hepatic ducts. The cystic duct makes a turn of a quarter of a circle before uniting with the hepatic duct. Note the unusual length of the common duct.

the vital structures can be more easily identified before being covered with clots or in-

Fig. 24. Posterior spiral mode of union of cystic and hepatic ducts. Note how the cystic duct winds around the posterior aspect of the hepatic duct to enter on the left border of the latter.

filtrated with blood as so frequently occurs when removal is begun at the fundus.

The cystic duct should be ligated preferably close to the common duct with some material which will resist intrahepatic pressure longest. I have found that fine kangaroo tendon is the most desirable for this purpose. In case there is parallelism or spirality of the cystic and main hepatic ducts, great care should be exercised in separating them before ligation of the cystic duct.

5. The cystic artery is easily isolated if it pursues its so-called normal course (Fig. 1). It should be ligated as close to the neck of the gall-bladder as possible in order to prevent pulling the hepatic artery out too far (*A* of Fig. 26). Anomalies of the various arteries can be easily avoided if one makes it a rule never to divide or clamp a strand of connective tissue in this region before one is certain that it does not contain some important duct or blood-vessel.

6. The cystic duct and artery should never be clamped until they have been isolated and ligated separately. I prefer to use the finest artery forceps for the duct and vessel, and only apply them as an additional safeguard after the ligatures have been applied.

7. The removal of the gall-bladder from its bed in the liver by the subserous method requires no special mention except to call attention to the anomalies of the hepatic ducts previously described.

8. The supraduodenal portion of the common duct is the preferable location for choledochotomy. The duodenum should be retracted downward and search made for anomalous arteries crossing the common duct obliquely (anomalous origin of cystic artery) or transversely (pancreaticoduodenal or main gastroduodenal). The nearer one approaches the pancreas the more vascular does the field become; hence it is best to avoid the retroduodenal portion of the common duct if possible.

9. The chief arterial and venous blood supply of the liver and gall-bladder pursues its course upward between the folds of the hepatoduodenal ligament. Severe bleeding from overlooked or retracting vessels may be best controlled by grasping this ligament between the index finger and thumb.

Let me again emphasize certain anomalies with which every surgeon must be familiar.

1. *The gall-bladder* may be (a) absent, rudimentary or hour-glass; (b) it may lie more or less completely enveloped by the liver (intrahepatic form); (c) the pelvis may be on the upper instead of the lower side (reversed ampulla or pelvis); (d) right hepatic duct may empty into the gall-bladder; (e) there may be transposition of viscera.

2. *The cystic duct* may be (a) double, i.e. there may be two cystic ducts; (b) the hepatic (right) duct may empty into the cystic duct; (c) an accessory hepatic duct may empty into either the cystic or the angle of junction of the cystic and main hepatic ducts; (d) the cystic duct may be so greatly dilated as to

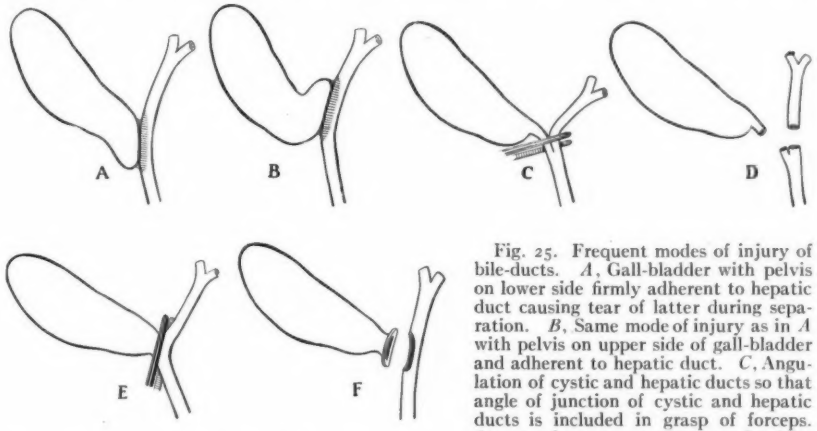

Fig. 25. Frequent modes of injury of bile-ducts. *A*, Gall-bladder with pelvis on lower side firmly adherent to hepatic duct causing tear of latter during separation. *B*, Same mode of injury as in *A* with pelvis on upper side of gall-bladder and adherent to hepatic duct. *C*, Angulation of cystic and hepatic ducts so that angle of junction of cystic and hepatic ducts is included in grasp of forceps. Apparently a very common mode of injury according to case reports. *D*, Results of such an injury as described in *C*, i.e. portion of hepatic or common ducts has been resected. *E*, Portion of wall of hepatic duct resected during clamping of a short or greatly dilated cystic duct. The results of such an injury are shown in *F*.

be almost indistinguishable from the main hepatic duct; (e) the cystic duct may be very small and extremely short; (f) parallelism (short or long) is present in 17 per cent and a spiral course of the cystic in 80 per cent of individuals.

3. *The hepatic ducts.* (a) There may be four or five instead of one main duct which is formed just outside of the liver; (b) there may be accessory hepatic ducts.

4. *The common duct* may be (a) extremely short or very long; (b) a double common duct may be present; (c) in nearly 95 per cent of individuals the common duct lies within the pancreas.

5. *The blood-vessels.* (a) There may be anomalies of the right hepatic artery; (b) of the single cystic artery; (c) of the double cystic arteries; and (d) of the gastroduodenal artery.

Report of Fifty-one Cases of Injuries of Bile-Ducts

IMMEDIATE OR EARLY OPERATION, I. E., WITHOUT SECONDARY OPERATION

Case 1. J. H. Jacobson. (Am. J. Obst., 1916, lxx, 948.) During a cholecystectomy (begun at the fundus) Jacobson resected the junction of the cystic, hepatic, and common ducts. An immediate end-to-end anastomosis of the hepatic and common ducts was performed. On the anterior surface perfect approximation was impossible. The patient was well at the time of making the report (10 months after operation).

Case 2. Koerte (quoted by Jacobson). During cholecystectomy, the junction of three ducts was excised. Circular suture was followed by recovery.

Case 3. Koerte (Idem). An extensive tear of the hepatic duct was made during cholecystectomy. Immediate circular suture was done and the patient recovered.

Case 4. DeWitt Stetten. (Med. Rec., N. Y., 1915, lxxxviii, 630). Stetten divided the hepatic duct completely during a cholecystectomy. The ends were at once approximated with fine chromic catgut reinforced anteriorly by a second row and some omentum. The patient made an uneventful recovery.

Case 5. Dobrucki (quoted by Kehr). During cholecystectomy Dobrucki placed a clamp on the proximal end of the cystic duct. After dividing he found that hepatic duct had been included. The duct was partly sutured and a tube inserted into the distal end. The patient recovered after a fistula had persisted for 2 months.

Case 6. F. Voelcker. (Beitr. z. klin. Chir., 1911, lxxii, 581). During a cholecystectomy, Voelcker accidentally resected a segment ½ centimeter long, of the common duct. He immediately did an end-to-end anastomosis with fine catgut over a rubber tube which was allowed to emerge through a separate incision in the supraduodenal portion of the common duct below the site of the anastomosis so that the tube could be pulled out through the incision in the abdominal wall on tenth day. Patient discharged on twenty-third day, wound healed.

Case 7. Reported by Voelcker but operated upon by assistant. The cystic duct was so dilated that its lumen could not be distinguished from that of the gall-bladder, so that during a cholecystectomy the common duct was completely resected. An end-to-end anastomosis was immediately done over a rubber tube which emerged, as in Case 6, through a separate opening in the supraduodenal portion of the common duct below the seat of injury. The tube was removed on the ninth day, and on the twenty-fifth day the patient was discharged with wound healed.

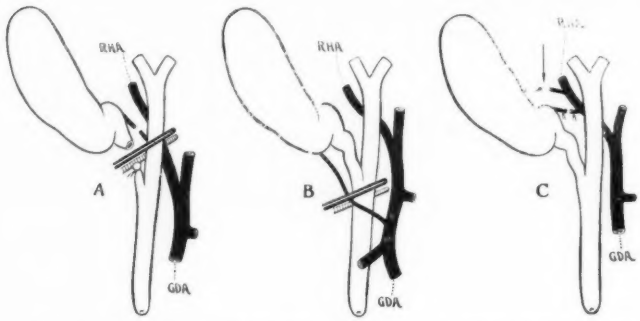

Fig. 26. How injuries of the bile-ducts occur. *A*, Cystic duct has been ligated after its division. Ligature of cystic artery cuts through and bleeding stump retracts behind hepatic duct which may be included in forceps. *B*, Anomalous cystic artery from gastroduodenal overlooked and forceps include duct in effort to control hæmorrhage. *C*, After one artery has been ligated or clamped. Arrow points to second cystic artery which has been overlooked.

CASES 8, 9, 10, 11 and 12. KEHR (Surgery of the Bile Passages, 1913, ii, 184). In five cases, during cholecystectomy, Kehr accidentally clamped a portion of the wall of the hepatic duct. All recovered and remained permanently well following suture in a transverse direction and the use of a T tube.

CASE 13. MOYNIHAN (Abdominal Operations, 1914, ii, 297). During cholecystectomy Moynihan found that he had resected or torn off the junction of the cystic, hepatic, and common duct, owing to fact that the gall-bladder was adherent to the hepatic duct. He sutured the common duct and inserted a tube into the common duct at a point below the suture line. The patient recovered.

CASE 14. KEHR. The hepatic duct was extensively torn during cholecystectomy. An immediate end-to-end suture was done and a fine catheter inserted into the hepatic duct. The patient recovered.

CASE 15. W. A. DOWNES (Ann. Surg., 1918, lxvii, 619). The cystic duct was found to be very short, entering the common duct obliquely. A portion of the common duct three-fourths of an inch long was accidentally removed while dividing a dense mass of adhesions. Immediate end-to-end approximation was attempted. The posterior wall of the common duct could be brought together fairly well, but the anterior part not so well. There was a profuse discharge of bile for 34 days, but this gradually ceased and the stools immediately began to show the presence of bile. Downes points out that there is danger of injury to the common duct if the cystic duct is not isolated before the clamp is applied, and also that the common duct can regenerate in a short period of time (31 days) if at least half of the circumference is approximated.

CASE 16. KEHR. A defect in the retroduodenal portion of the common duct was found after removal of calculi. The cystic duct stump was used to cover the defect. The patient recovered.

CASE 17. KEHR. The common duct was included in the clamp during cholecystectomy. The defect was covered by a pedunculated flap from the stomach, composed of serous and muscular coats. The patient died from pneumonia on the sixth day.

CASE 18. KEHR. An immediate hepatoduodenostomy was done after accidental excision of the hepatic and common ducts during cholecystectomy. Through a second incision in the duodenum, the end of the duct was sutured to the mucosa of the duodenum. Kehr prefers this to Wilms' method of anastomosis with a tube. The patient recovered.

CASE 19. KEHR. The hepatic duct was divided during cholecystectomy. Reconstruction of common duct was accomplished with aid of rubber tube, and the patient recovered.

CASE 20. KEHR (vol. i, p. 135, of his book published in 1913). There was an anomaly of the right hepatic duct (Fig. 9) which emptied into the cystic duct. Two calculi lying in the former were thought to be in a diverticulum of the cystic duct, thus the right hepatic duct was divided while splitting open the cystic duct. Both hepatic ducts were approximated to the common duct by circular suture over a Y-shaped tube, one limb of which was inserted into each hepatic duct and the main portion of tube allowed to emerge through a separate opening in common duct below the suture line (Voelcker's method—see Fig. 28, *E*). The patient recovered.

CASE 21. GINSBURG and SPEESE (Ann. Surg., 1917, lxv, 79). The common duct was divided during cholecystectomy, the cystic and hepatic ducts being parallel. A T-tube was inserted into the ends of the divided ducts 9 days later, and the horizontal portion of tube enveloped in a flap taken from the posterior sheath of the rectus. This flap was sutured like a cuff around the end of the duct and also to the wall of the duodenum, the center of the transplant being perforated for the exit of the tube. Two months later the patient was again operated upon and the tube was found displaced and resting on the duodenum, but the fascial transplant appeared viable. A small rubber tube was passed into the duodenum and covered by a fascial transplant reinforced by omentum. Three months later a fourth operation was done for epigastric distress and because the tube had not passed. The tube could not be removed. A temporary biliary fistula was followed by perfect recovery (4 months after final operation).

CASE 22. DAHL (Nord. Med. Ark., 1908, No. 2 and Ztschr f. Chir., 1909, p. 266). A portion of the common duct was excised during cholecystectomy. Dahl performed the first hepaticojejunostomy. The jejunum was completely divided 30 to 40 centimeters below the duodenojejunal flexure. The proximal end was implanted lower

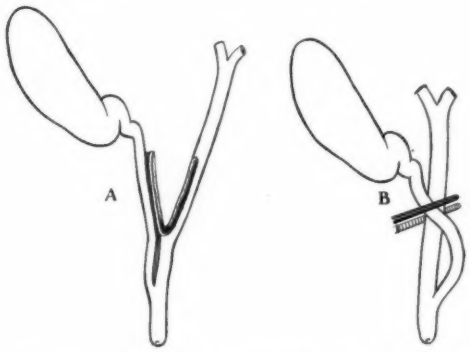

Fig. 27. *A*, Shows how a portion of the hepatic duct is torn off if the operator fails to note a parallelism of the cystic and hepatic ducts. *B*, Shows how the hepatic duct can be included in grasp of forceps if the operator fails to note a spiral course of the cystic duct.

down into the jejunum while the distal end (similar to the Roux Y method) was carried through an opening made in the transverse mesocolon and united to the hepatic duct. The patient recovered.

CASE 23. H. WOLFF (Zentralbl. f. Chir., 1914, xli, 231). Wolff intended to perform a cholecystectomy but after dividing what was thought to be the cystic duct, it was deemed inadvisable to remove the gall-bladder owing to dense adhesions. When this second step was undertaken, 5 days later, it was discovered that the common duct had been divided instead of the cystic. Owing to the weakened condition of the patient, a plastic operation was done 2 months later. Because of the intact condition of the cystic duct, it was possible to mobilize the gall-bladder and to anastomose the fundus with the distal portion of the common duct. Bile appeared in the stools on the tenth day, and at the time of reporting the case (4 years later), the patient was perfectly well.

CASE 24. JENCKEL (Deutsche Ztschr. f. Chir., civ, 40) found, 8 months after a cholecystectomy, an obliteration of the common and lower part of the hepatic ducts for a distance of 8 centimeters. He inserted a tube into the hepatic duct and carried it into the duodenum, by the Witzel method. Four weeks later, when the tube was removed, a canal lined by epithelium was found. The patient was well 4 years after this operation.

CASE 25. JOHN HOMANS (personal communication). Upon attempting to free the pelvis of the gall-bladder from the hepatic duct as the first step of a cholecystectomy in a case in which the gall-bladder was very sessile and deeply imbedded in the liver, a structure was separated which appeared to be a large cystic duct. The latter was clamped and divided and removal of the gall-bladder continued. Bile was now noted to be flowing from a structure (very close to the gall-bladder) which proved to be the main hepatic duct. There had evidently been such a strong fibrous union between a reversed ampulla or pelvis of the gall-bladder and the main hepatic duct that no line of cleavage could be made out. A suggestion of cystic duct one-eighth inch long was demonstrated. The tear in the hepatic duct was immediately repaired with fine silk and end-to-end anastomosis made of the common duct. There was an abundant leakage of bile for the next 3 weeks, but this decreased so that she left the hospital in

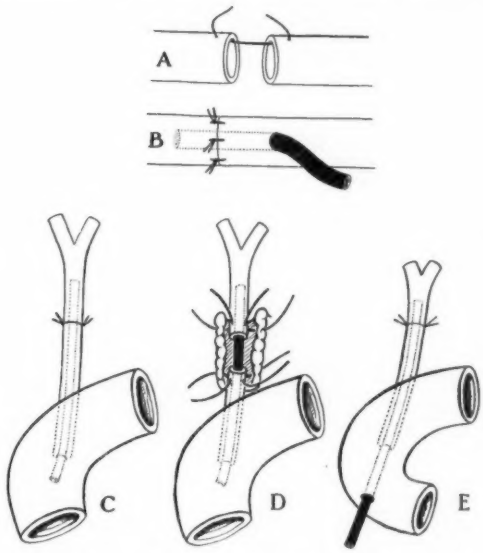

Fig. 28. Methods of repair of injuries of the bile-ducts. *A*, End-to-end anastomosis with suture. *B*, End-to-end anastomosis over drainage tube allowed to emerge through a separate opening in common duct. *C*, Same as *B* but drainage tube emerges through ampulla of Vater, i.e. traverses the entire length of the common duct and extends beyond point of anastomosis into the hepatic duct. *D*, Reconstruction of hepatic or common duct over rubber tube with aid of omentum or vein or a fascial flap. *E*, End-to-end anastomosis of common or hepatic duct over rubber tube allowed to emerge through separate openings in duodenum (transduodenal drainage).

the fourth week with normal stools and excellent general condition.

CASE 26. F. B. LUND (personal communication). Cholecystectomy was done for gall-bladder full of calculi and very adherent to common duct. In making traction on the gall-bladder, the common duct was angulated and one-half inch of this duct resected. With some difficulty a circular suture immediately was done. There was a slight leakage for a time but the patient ultimately recovered.

II. IMMEDIATE OR EARLY OPERATION FOLLOWED BY SECONDARY OPERATION

CASE 1. O. NORDMANN (Verhandl. deutsch. Gesellsch. f. Chir., Berl., 1913, xlii, part 2, 287). In this case there was either an absence of the cystic duct or the lumen of the latter was so large as to be indistinguishable from that of the gall-bladder. In clamping the supposed cystic duct, a segment of the hepatic and common ducts at their junction was resected. A primary end-to-end suture of the divided ducts was done, but was followed by persistent icterus, necessitating a secondary operation two months later. Nordmann found a stricture at the seat of the former anastomosis. After freeing the hepatic duct he pulled up a loop of jejunum. A rubber tube was inserted into the hepatic duct and the latter brought as close to the

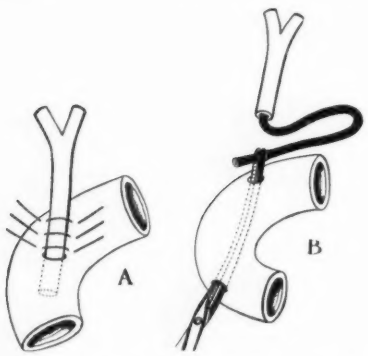

Fig. 29. Methods of anastomosis. *A*, Hepatoduodenostomy. Hepatic duct anastomosed by Witzel or Coffey method with duodenum. *B*, Hepatojejunostomy (Nordmann's case). Hepatic duct implanted into a coil of jejunum over a soft catheter which was allowed to emerge at a lower point in the bowel.

jejunum as possible and a canal built up in the wall of the bowel around the tube by the Witzel method. The tube was carried through an opening on the proximal side of the jejunal loop and permitted to emerge through a second opening on the distal side of the same loop. Finally an entero-anastomosis was done. There is no mention of the outcome of the case.

CASE 2. F. VOELCKER (Beitr. f. klin. Chir., 1911, lxxii, 581). During cholecystectomy by another surgeon, 2 centimeters of the common duct at its junction with the hepatic duct, were resected. Six days later, the patient was reoperated upon by same surgeon on account of fever and complete biliary fistula. A soft rubber catheter was inserted into the ducts across the defect and covered with the hepatoduodenal ligament and liver so as to form a canal.

The patient was operated upon by Voelcker 4 months later on account of all the bile being discharged through the wound since second operation. Voelcker was able to approximate the ducts with a circular suture over a rubber tube which emerged through the wall of the descending portion of the duodenum—by the Witzel method—and then through the external incision, enabling the operator to remove it on the fourth day. The patient was discharged on the twentieth day. Voelcker used this method of transduodenal drainage without knowledge of the application of a similar method by Stubenrauch.

CASE 3. H. H. LYLE (personal communication to Eliot). In a cholecystectomy, a portion of the common duct was excised. Immediate end-to-end suture was done. The sutures did not hold and a permanent biliary fistula developed. Six months later, after an unsuccessful suture of the divided ends of the common duct in the course of a cholecystectomy, operation revealed a stricture—between ½ and ¾ of an inch in length, surrounded by numerous adhesions—which was excised. The posterior edges were approximated by suture. As the anterior edges could not be sutured, a rubber catheter was passed up into the hepatic duct and down through the common duct into the duodenum. The exposed part of the catheter was covered with the round ligament and omentum. The catheter was passed on the thirteenth day.

The patient remained well for 2½ years and then began to complain of attacks of pain. Lyle states that she was operated upon by another surgeon in October, 1916, who found a stricture of the common duct with biliary calculi on the proximal side. In January, 1917, Lyle examined her and at that time there seemed to be developing a recurrence of the calculi.

CASE 4. D. B. PHEMISTER (Surg. Clinics, Chicago, 1917, i, 555). Phemister reports a case in which the hepatic duct was included in the forceps while attempting to grasp a cystic artery which had retracted. A T tube was employed to bridge the 1 centimeter gap and was wrapped with omentum. The tube was pulled out 3 months later. The patient developed a persistent icterus and was reoperated upon by A. D. Bevan about 1 year later. At this secondary operation a stricture a little over 1 centimeter long was found in the hepatic duct. A No. 12 catheter was inserted into the hepatic duct on the proximal side and into the duodenum through the common duct on the distal side.

After excising the stricture, only the posterior wall of the duct remained so that it was necessary to employ omentum to form the anterior wall over the rubber tube. Roentgenograms taken at the end of 4 weeks showed that the tube was still in place.

III. SECONDARY OPERATION ONLY

CASE 1. J. F. ERDMANN (Ann. Surg., 1918, lxvii, 370). A woman had the gall-bladder removed 6 months before by another surgeon, who believed he had included a portion of the hepatic duct while attempting to check bleeding from the cystic artery. The patient became jaundiced 3 days after this primary operation and a persistent biliary fistula developed. At the secondary operation by Erdmann, a scar was found nearly an inch long occupying the site of the common duct. A catheter was introduced into the hepatic duct and its distal end passed into the duodenum, the scar tissue being divided so as to envelop the catheter. The omentum was sutured around the exposed portion of the catheter. The latter was passed one month later.

CASE 2. ERDMANN. Following a cholecystectomy by another surgeon, persistent jaundice developed. At the secondary operation cicatricial tissue was found occupying the site of the junction of the hepatic and common ducts. The same method of repair was employed as in the first case.

CASE 3. I. S. HAYNES performed a secondary operation where another surgeon had resected ¾ of an inch of the common duct during a cholecystectomy, followed by severe icterus. Haynes inserted a small rubber tube into the hepatic duct and then through the distal portion of the common duct into the duodenum. The patient died 3 days later from hæmorrhage.

CASE 4. BEHREND (Ann. Surg., 1918, lxviii, 32). Cholecystectomy 3 months before, by another surgeon, was followed by chills, fever, jaundice and acholic stools. At the secondary operation, a defect was found in the common duct. The greatly dilated proximal portion of the hepatic duct was anastomosed with great difficulty to the duodenum and a tube placed in the anastomotic opening. On account of persistent icterus, the patient was re-operated upon on the twenty-first day. The site of the anastomosis was found patulous but a T tube inserted. This tube was removed 10 days later. Recovery was apparently complete at the time of the report of the case.

CASE 5. W. F. FOWLER (Surg., Gynec. & Obst., 1918, xxvii, [illegible]). Fowler found a stricture in the common duct following injury during cholecystectomy. He inserted a No. 12 French catheter into the hepatic duct and anchored it with two chromic gut sutures through the posterior wall of the duct. The tube was then inserted into the duodenum

through a stab wound, and the remainder of the circumference of the common duct completed by folding the duodenum around the tube. The ultimate outcome was not known.

CASE 6. F. HAGLER (Surg., Gynec. & Obst., 1918, xxvi, 689). During a cholecystectomy performed by another surgeon 3 months before, a tear 1 centimeter long was found to have occurred in the common duct. At the secondary operation by the author (3 months later), a defect 2 centimeters long was found in the supraduodenal portion of the common duct with a normal lumen on the proximal side. The distal end could not be found. A No. 17 French catheter was inserted into the hepatic duct on the proximal end into the duodenum. At the site of the defect (2 centimeters) the tube was covered with omentum, which was sutured with chromic gut proximally to the hepatic duct and distally to the duodenum. The immediate result was good, the tube being passed 9 weeks after operation. Chills, fever, general abdominal pains, vomiting, and diarrhœa developed 7 months after operation. The patient became deeply icteric and died. At autopsy the hepatic duct was found patulous at the site of anastomosis but filled with purulent bile. The liver showed multiple abscesses.

CASE 7. A. WERELIUS (J. Am. M. Ass., 1917, lxviii, 1545). Cholecystectomy done one week before followed immediately by symptoms of common duct obstruction. At secondary operation the junction of the cystic, hepatic and common ducts was found to have been resected with a gap one and one-half inches long between the ligated ends of the hepatic and common ducts. Werelius was able to approximate the divided ends and unite them with a fine, continuous, silk suture. The edges on the posterior surface were inverted, while those on the anterior edge were everted and covered with omentum. The stools became yellow on the third day but a biliary fistula persisted for 2 months and then closed spontaneously, with ultimate recovery.

CASE 8. DELATOUR (personal communication to Eliot). The middle of the common duct was divided transversely during choledochotomy. At secondary operation stricture was found. Cholecystenterostomy was done with a Murphy button. The patient made an excellent immediate recovery. The end-result could not be ascertained.

CASE 9. MCARTHUR (personal communication to Eliot). Injury was done to the common duct during cholecystectomy (by another surgeon) followed by stricture. A straight rubber tube was inserted into the hepatic duct and allowed to protrude into the duodenum. The tube passed 8 weeks later. The patient died 2 years later of carcinoma of the stomach.

CASE 10. WILMS (see Brandt, Deutsche Ztschr. f. Chir., 1912, cxix, 345). In ligating the cystic duct during a cholecystectomy, the upper part of the common and the lower part of the hepatic ducts were resected. Six days later the patient was re-operated upon on account of the septic condition. Anastomosis with a rubber tube was made between the hepatic and common ducts, the exposed portion of the tube being covered by liver and hepatoduodenal ligament. This was followed by a biliary fistula. At the third operation a gap 2 centimeters long was found between the hepatic and common ducts, and the soft rubber catheter which had been used to form the anastomosis in the first attempt at repair of the injury, was found kinked. After excising the scar tissue corresponding to the gap, the common and hepatic ducts were united by circular suture, a rubber tube was inserted, and a transduodenal drainage of the hepatic duct was done according to the method of Voelcker. There was a recurrence of pain, fever, and icterus. At fourth operation a stricture of hepatic duct was found. A hepatic gastrostomy (Witzel) with tube was done. Again the patient had icterus, chills, and fever. At fifth operation, 18 months after the primary operation, a tube was inserted into the hepatic duct at one end and into the stomach (Witzel) at the other, and covered by a flap from the stomach wall. Apparent recovery at last report 6 months after operation.

CASES 11 AND 12. KEHR. Excision of stricture 1 centimeter long in hepatic duct, following damage in cholecystectomy. A circular suture was done. The patient recovered. Same etiology and procedure in both cases.

CASE 13. KEHR. The junction of the hepatic and cystic ducts was excised during cholecystectomy. Six months later, the stricture was excised and the interval of 1 centimeter bridged over by suture.

CASE 14. KEHR. The hepatic duct was divided in a cholecystectomy. One month later a tube was inserted into the hepatic duct above and the common duct below. The tube was removed 4 weeks later by traction on silk sutures. No mention of end-result is given.

IV. MISCELLANEOUS CASES[1]

CASE 1. DELAGENIÈRE quoted by Kehr, but no details given. Accidental division of ducts during cholecystectomy, followed by recovery.

CASE 2. MOYNIHAN. After cholecystectomy Moynihan found bile flowing from a duct wounded obliquely, which had probably been mistaken for a vein and divided. Only inserted split tube to stump. Recovery uneventful.

CASE 3. MOYNIHAN. Cholecystectomy was done beginning at the fundus. The main hepatic duct was found adherent to the posterior aspect of the cystic duct so that a portion of the anterior wall of the hepatic duct was excised during the removal of the cystic duct. Tube inserted to stump of cystic duct. Recovery uneventful.

CASE 4. LILIENTHAL (Ann. Surg., 1918, lxvii, 619). The hepatic duct was ligated by mistake, it being mistaken for the cystic duct. The accident was not discovered until icterus developed and the patient died.

CASE 5. JOHN T. BOTTOMLEY (personal communication). During cholecystectomy a portion of the hepatic duct was included in the ligation of the cystic duct and artery. Jaundice appeared on the day after operation. The patient was re-operated upon 6 days later and the main hepatic duct found almost completely occluded. The ligature which had included the hepatic duct was divided and a small catheter introduced into the common duct through the stump of the cystic duct. Recovery was uneventful. The patient has remained well.

CASE 6. E. A. CODMAN (personal communication). A cholecystotomy was done in 1912 for empyema of the gallbladder filled with calculi. Cholecystectomy was done 5 years later. When the cystic artery was tied the ligature slipped and the artery was again caught and ligated. The patient had unusual pain for the first 48 hours after the operation, but this ceased when on the third day a profuse discharge of bile came through the wound. At the same time jaundice appeared and on the fourth day, evidence of right-sided pneumonia. Death occurred on the sixth day.

At autopsy, the hepatic duct was found to have been divided, just above the junction of the cystic duct. This condition was a complete surprise to the surgeon, for he had felt absolutely confident that he had removed the gallbladder according to the usual technique. He could not understand how he could have divided the duct.

[1] In this group are included (a) cases in which only a drainage tube was inserted down to seat of injury—as in Moynihan's cases; (b) cases in which no details are given; (c) cases in which the accident was not discovered during life; and (d) in which the accident was discovered but no operation done; (e) cases in which accident was discovered after a short interval and a ligature cut (Bottomley's case).

After seeing the writer's specimens[1], the surgeon stated that he now for the first time could explain the occurrence, on the ground that an anterior cystic artery and the hepatic duct were included in the ligature which slipped. It is easy to see that if there were a short cystic duct and traction was made on the gall-bladder, the hepatic duct and the anterior cystic artery would lie parallel, and the duct would be concealed by the artery.

In this case, after the slipping of the tie, the surgeon picked up and ligated the artery, cleared the field of blood, and then probably ligated the duct, mistaking it for a vein. The immediate postoperative pain was due to the consequent biliary obstruction, which gave way on the second day when the profuse discharge of bile started. Jaundice did not appear for 48 hours in spite of the ligation of the duct.

[1]This case was reported in the discussion of a paper on this subject read by Dr. Eisendrath before the Boston Surgical Society, Feb. 2, 1920.

CASE 7. D. N. EISENDRATH (personal case). During cholecystectomy for acute cholecystitis with calculi many adhesions were found around the neck of the gall-bladder. The cystic duct was ligated close to the common duct and a vessel ligated which was thought to be the cystic artery. Upon dividing the stump a very severe hæmorrhage occurred from a second cystic artery and during an attempt to grasp this vessel, a portion of the hepatic duct was included in the blades of the forceps. The patient became quite icteric and had all the evidences of an obstruction of the common duct, accompanied by fever, but no chills. At a secondary operation, 4 weeks later, repair of the injury was deemed inadvisable on account of the great number of adhesions. Several small abscesses were noted on the liver surface. The patient has had recurrent attacks of cholangeitis with evidence of obstruction of the common duct at intervals since that time.

SURGERY AND EMBRYOLOGY[1]

BY JAMES E. THOMPSON, M.B., B.S. (LOND.), F.R.C.S. (ENG.), F.A.C.S., GALVESTON, TEXAS

NO greater compliment can be paid to any man than to be raised to a position of trust and eminence by his peers. I, therefore, thank the Fellows of the Southern Surgical Association for the great honor they have conferred on me by electing me president of this society whose 225 Fellows stand for all that is best in modern surgery.

It now becomes my sad duty to announce to you the deaths of five of our Fellows: Nicholas Schilling, of Cedar Bayou, Texas, one of the founders; John Young Brown, of St. Louis, Missouri, president in 1913; Stewart Wylie Pryor, of Chester, South Carolina; Isaac Lafayette Watkins, of Montgomery, Alabama; and John C. Wysor, of Clifton Forge, Virginia. We bemoan their loss and send to their bereaved relatives messages of deepest sympathy.

I stand before you today with mingled feelings—of humility, because I alone know how little I deserve the distinction, and of pride, at having my name placed among those distinguished predecessors whose reputation will last as long as American surgery is remembered. In my most ambitious moments I never aspired to the honor, and, like all favors unsought, it carries the greater distinction.

My election as a fellow of this association dates from the Louisville meeting in the year 1892. It was my good fortune to be sent there by the regents of the University of Texas as their representative to attend a meeting of the southern medical colleges to consider the advisability of raising the standard of medical education in the South. Coming from an institution only one year old, absolutely without prestige, history, or reputation, and myself its representative very young, unknown in America, with my professional reputation yet to make, I attended the meeting with many misgivings and some fear, all of which I found to be totally unfounded, since my reception turned out to be of a most flattering character. I was treated with the greatest consideration by everybody whom it was my good fortune to meet, and my recollections of the personalities of these gentlemen are singularly vivid even after the lapse of so many years. To meet such notables as Yandell, Howard Kelly, McMurtry, W. D. Haggard, Sr., McFadden Gaston, Cartledge, Palmer, Wathen, Rodman, Roberts and others equally distinguished, was an event that has since been reckoned as one of the milestones of my life. I was at an impressionable age, very much of a hero-

[1] Presidential address presented before the Southern Surgical Association, New Orleans, December, 1919.

worshiper and profoundly flattered at my favorable reception by men who at that time were the backbone of the surgical profession of the South. It is always pleasant to think of the meeting as one where I made my professional debut, and where friendships began that have continued to the present time.

I can never repay the debt I owe to this society. In spite of considerable shortcomings as to attendance on the meetings some years back, I have during the past 12 years been a very regular attendant. Even during the period of my neglect the *Transactions* were read by me from cover to cover and were a never-failing source of pleasure and profit. For many years I have sat through the sessions listening to papers and discussions equal to those in any similar society in the world. I have now reached a point where I look forward to the meetings as a source of such educational stimulus that attendance has become an urgent necessity, for they constitute a sort of intellectual exchange where new ideas and thoughts, after being subjected to searching criticism, and winnowed as it were, like grain from the chaff, are bestowed upon us with a bountiful hand. Each year when I receive the program of the meeting I am astonished at its range and dismayed by its profundity. Usually there is one paper, or at the most two, that I feel capable of discussing feebly. The rest are so technical and exclusive that it is vanity to pretend for a moment to more than a superficial knowledge of their scope. It has often occurred to me that my mental perplexity must be shared by most of the Fellows and that I am not alone in this feeling of hopelessness and inability to keep abreast of the advances in surgery. In my own particular case, I have become resigned and look upon it as a healthy symptom. Just as "a cold nose is a sign of a healthy pup," so must I interpret my rigors of apprehension when faced with the terrors of one of our programs. I have promised my better self during moments of introspection, to cease attending the meetings of this Society whenever I feel thoroughly at home with the subject matter of any program that reaches me. Until that time comes, and with it mental decay, I expect to occupy a chair at every annual meeting.

I have chosen as the title of my address, "Surgery and Embryology." A year ago our worthy secretary suggested to me that an address of a scientific character would be agreeable and I assented. The choice of a title was one of great difficulty. In selecting a subject to present to you I had to choose between one of special or esoteric and one of general interest. My choice of the latter was not made without some misgivings because I was afraid I might be tempted to abuse your generosity and ramble too far afield. More especially was I apprehensive that in my enthusiasm I might choose for detailed consideration phases of the vast subject full of fascination for myself but deadly boring to my hearers.

As the subject of surgery and embryology is rather extensive, I shall confine my remarks to the description of a few abnormalities of great surgical importance. To this end I shall consider the subject under two heads: first, I shall present a general survey of some abnormalities in the abdomen, and secondly, I shall give a somewhat detailed description of cysts in the neck arising from remains of the branchial clefts, with special reference to the origin of ranula.

Human anatomy viewed merely from the standpoint of bones, muscles, nerves, viscera, etc., is perhaps one of the most difficult of all studies to learn and retain in one's memory. If taught without comparison between the anatomic structures of man and those of the other vertebrates the study becomes a dull grind and a hopeless presentation of facts without meaning or purpose. But if the student has a clear understanding of the stages by which the organs of men have reached their adult development, and the marvelous changes and modifications that have taken place in them during the transition of man from the lower vertebrate types, the subject becomes one of absorbing interest. From such a standpoint each structure and organ has its own history which is inseparably connected with that of similar structures in the lower animals; and the parallel histories of these organs in each species form, as it

were, a contemporary history of every species through all eternity. Viewed from this aspect human anatomy becomes a fascinating and romantic study where reason is added to mere fact, and purpose takes the place of coincidence.

A few notable examples of the interdependence of human and comparative anatomy and embryology may be cited as illustrations.

In amphibia the right and left aortic arches both persist; in birds the right aortic arch alone survives; in man and other mammals the left survives.

The complex relationships of the genital glands and their ducts and the permanent kidney and ureter cannot be mastered intelligently without accurate knowledge of the adult forms in the lower vertebrates. The wolffian body and duct signify mere names unless they are studied in amphibia and fishes, where the wolffian body forms the functional kidney and its duct serves as the functional ureter in both sexes and the seminal duct in the male. In reptiles and the higher vertebrates the wolffian body is a temporary embryonic structure which never exercises any renal function. Parts of it persist permanently as excretory tabules for the male genital glands. The rest disappears in both sexes, although vestigial remains are found in both the male (the hydatid of Morgagni, vas aberrans and the organ of Giraldes) and in the female (epoophoron and paroophoron) which are occasionally responsible for pathological conditions, such as cysts of the testicle or broad ligament. The wolffian duct functionates in the male as the vas deferens, but disappears in the female. Occasionally it persists as the duct of Gaertner and may be responsible for cysts on the posterior surface of the uterus and the wall of the vagina.

The permanent kidney of the higher vertebrates is a new structure (the metanephros) which is developed in the sacral region of the embryo in connection with a diverticulum from the lower end of the wolffian duct (renal bud). With the growth upward of the renal bud the metanephros ascends to its permanent position in the lumbar region. Failure to ascend is responsible for pelvic or iliac ectopia. Failure to ascend caused by fusion of the right and left glands produces the horseshoe kidney.

The genital glands are developed on the inner aspect of the wolffian bodies and are situated at the anterior end of the cœlom. In the male, the gland tabules connect with those of the wolffian body and so open into the wolffian duct which becomes the vas deferens. In the female the ova are extruded into the cœlom and eventually pass into the open end of a tube, the muellerian duct, which in the lower vertebrates passes downward and opens separately into the cloaca. In mammals the upper end of each tube forms the fallopian tube. The lower parts fuse together and form the uterus and vagina. Failure in union is responsible for bifid uterus and double vagina (vagina sæpta). The descent of the genital glands is noticed early. The testicle is in the iliac fossa in the third month, and in the eighth month it leaves the inguinal canal. The descent of the ovaries is usually arrested normally at the pelvic brim. Both organs may be retained in their early embryonic positions. Retention of the testis is so common that it may be passed without comment; that of the ovary is a rarer anomaly. One interesting example came under my observation some time ago. While operating on a patient supposed to be suffering from appendiceal colic, I discovered a band running diagonally across the front of the ileocolic junction. It passed from the right renal region downward and medially into the pelvis. Below, it was traced into the right upper cornu of the uterus, with which it blended. Above, it passed into a hard, rock-like mass which lay in front of the right kidney. The pelvic organs and intestines were fixed together by adhesions of a peculiar consistency, unlike those produced by an infective peritonitis, which made it impossible to separate the uterus from the gut. I was unable to inspect the left uterine cornu or feel the left ovary or tube. The right cornu I denuded, and found that the band of tissue, which felt like a tube, was continuous with it. I was unable to discover a right ovary in this situation. While handling the band it was felt to consist of two fairly distinct portions or cords. Through a second incision parallel

with the upper right costal margin, we cut down on the hard rock-like substance. This was found to lie in a mass of adhesions situated in front of the right kidney and to the outer side of the hepatic flexure of the colon. After enucleation, it was seen to consist of calcified material to which the upper end of the double band previously described was attached. Suspecting that the calcified mass represented an undescended ovary and that the band represented the fallopian tube, the specimen was excised and examined carefully. Microscopic examination of the band showed two separate tubes, one of which probably represented the fallopian tube and the other a persistent wolffian duct. Microphotographs of the sections with legends attached, are appended in confirmation of this statement (Figs. 1 and 2). We have not yet been able to discover the exact origin of the calcified mass, but the supposition is that it represents a calcified ovary.

Cases of imperforate anus with openings between the lower end of the rectum and the urethra (urogenital sinus) in the male or the vulva in the female can hardly be explained without reference to adult forms in the lower vertebrates, because we are unable to find evidence at any stage in the development of the human embryo that the rectum opens at any of these sites. If, however, we study the adult conditions in amphibia, reptiles, monotremes and marsupials, we find the rectum opening in situations which tally precisely with those of the abnormal openings occurring in man. One of the commonest malformations, namely, where the anus is imperforate and the rectum opens into the vulva (in the female) is almost an exact reproduction of the adult stage of marsupials.

The inference is clear that the organs of man have passed through these stages in reaching their present development, but that in some manner the steps of the process have been suppressed in the development of the embryo.

Nothing can be more fascinating than a study in which truths stand suddenly revealed by a new arrangement and correlation of observations which individually are of mere academic interest. It is like finding new beauties in a picture or hidden meanings in a beloved book. Happy is the man who sees and understands, and unhappy he who is blind to the path beyond the open door, whose windows remain always barred to the universe and to whom, like Peter Bell—

"A primrose by a river's brim
A yellow primrose was to him,
And it was nothing more.

"The soft blue sky did never melt
Into his heart; he never felt
The witchery of the soft blue sky!"

Most human beings are born singularly perfect and apparently free from anatomical abnormalities. Yet a tour of observation through any dissecting room will reveal anomalies present in most of the bodies on the tables. Of all the structures in the body, the arteries show the greatest number and variety of anomalies, a fact which probably can be explained by the ease by which the collateral channels can enlarge if parent trunks are obstructed. Those affecting arteries most commonly ligated we may pass over because they are well known to teachers of operative surgery and consequently to surgeons in general. Others, particularly those occurring in the visceral arteries, occur more frequently and are less known. Variations in the origin and distribution of the mesenteric arteries are very common. The right colic artery is frequently absent, its place being taken by a branch from the ileocolic or the middle colic; or the middle colic may be represented by a branch from the right colic. The arteries of the liver are subject to great variation. The left lobe of the liver is often supplied entirely by a branch of the left gastric artery. In these cases the main hepatic trunk derived from the cœliac axis is distributed exclusively to the right lobe and the gall-bladder. Occasionally the left lobe receives its blood supply from the main hepatic trunk, aided at times by a branch from the left gastric, while the right lobe and gall-bladder receive their blood supply from a large trunk which takes its origin from a neighboring artery, usually from the superior

mesenteric. This trunk usually passes behind the portal vein in its course to the liver.

Some time ago I made a tour of the dissecting room with Professor H. O. Knight for the purpose of examining the abdominal cavities of twenty-three cadavers which were open to inspection at one time. Although the number of bodies inspected was small and the abnormalities were comparatively few, they form an interesting list which I shall present to you in tabular form:

	Cases
Arrested rotation of colon	1
Presence of Meckel's diverticulum	0
Absence of vermiform appendix	1
Abnormalities in hepatic vessels	9
Low position of kidneys (lower pole below crest of ilium)	2
Jejunum, commencement of, passing to the right	3
Congenital absence of spleen	1

In such a small number of bodies the list is very instructive and, with the exception of the congenital absence of the spleen, it is probably a fair average of the yearly findings. The arrested rotation of the colon affected the lower end of the ascending colon and ileocæcal junction. This part of the bowel had failed to rotate and to unite to the peritoneal surface of the flank. The ileum entered the cæcum from the right side. As Meckel's diverticulum is said to be present in 2 per cent of bodies and one specimen was found last year in 18 dissected bodies, its absence is not surprising. A dissection of the cases with abnormal hepatic arteries showed 3 cases in which the right hepatic artery came from the superior mesenteric. In every case the cystic artery arose from the right hepatic. The cases where the first 2 feet or so of the jejunum passed to the right are worth notice. For a number of years past Professor William Keiller has called my attention to this point. It has a special bearing on the technique of the no-loop operation of gastrojejunostomy as practiced in the so-called Mayo operation and would call for a reversal of the manner of placing clamps on the jejunum (Fig. 3).

This list of abnormalities, small as it is, gives an insight into the possibilities that may confront a surgeon who is exploring, not twenty three abdominal cavities, but hundreds each year.

Every operator expects the viscera to occupy normal positions, and if he fails to find the organ he is searching for, he hunts for it where previous experience has taught him he is most likely to find it. If he has been carefully trained in embryology he will know beforehand where to look and what to observe; but, if not, he will probably begin a ramble over the greater part of the abdominal cavity, which may end disastrously for the patient. Cases of misplaced vermiform appendix and arrested rotation of the cæcum fall in this category and are responsible for some of the most puzzling conditions.

Intestinal abnormalities, being more frequently met with than those of the other abdominal viscera, will receive almost exclusive attention in this communication. They result from arrest of or failure in the rotation of the colon, or to speak more correctly, the intestinal loop, at an early period of embryonic life; a fault which is responsible for all the cases of misplaced cæcum and vermiform appendix. Starting with the lower portion of the left hypochondrium as the probable embryonic position of the cæcum, it may be found arrested at any point between this and the right iliac fossa along the line of its normal descent, which follows approximately that of the normal transverse and descending colon. It is seen so frequently just below the level of the gall-bladder that a differential diagnosis between appendicitis and cholecystitis is often a matter of considerable difficulty. I have frequently seen it to the left of and above the level of the umbilicus (Fig. 7). In one of my cases, fatal typhoid perforation occurred in a cæcum situated here. In another case during an exploratory laparotomy I found the cæcum in this position embedded in a rolled up mass of omentum so thick that it could not be unraveled. The large intestine coursed downward from it as a perfectly straight tube; and, to my surprise, it passed over the right brim of the pelvis. There was practically no sigmoid loop. The left flank contained no large intestine.

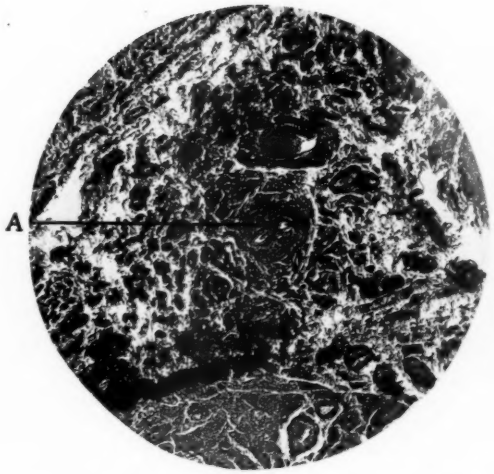

Fig. 1. Section of band of tissue showing muellerian duct. *A*, cross section of duct which here is double.

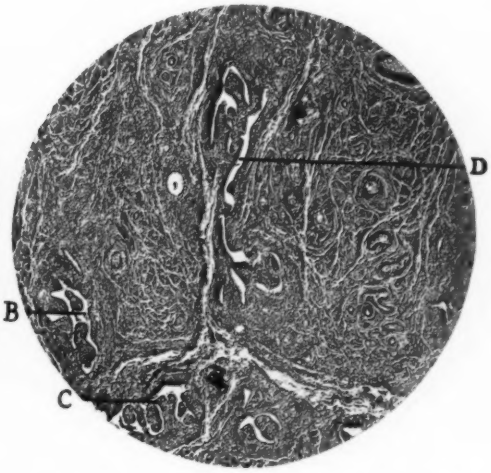

Fig. 2. Section of band of tissue showing vestigia wolffian body. *B*, *C*, *D*, point to wolffian tubules.

In order to understand these abnormalities, it is necessary to visualize clearly the steps of the rotation and the changes in the respective positions of the large and small intestines during the process.

In the *fifth week* of embryonic life the shape of the alimentary canal is that represented in Fig. 4. The foregut is firmly fixed by both dorsal and ventral mesenteries. The mid and hind guts are slung up to the posterior body wall by their dorsal mesenteries only. The ventral mesenteries have disappeared. The mesentery of the mid gut is long and the intestinal tube forms a long U loop from the convex end of which the vitelline duct passes through the umbilical opening to the yolk sac. Where the limbs of the U loop join the fore and hind guts, there are acute bends, and the gut has little mobility above and below these points. The U loop which is supplied by the superior mesenteric artery is not able to move very freely in a lateral direction, because its apex is fixed by the attachment of the vitelline duct to the umbilicus. It is, however, able to rotate around its base where the two limbs of the U are close together. After the fifth week the mid gut increases in length very rapidly, far outstripping the other divisions of the alimentary canal. Its mesentery becomes fan-shaped and capacious except at the base of the loop where the limbs of the U join the rest of the gut. Here the mesentery is reduced to a narrow isthmus (duodenocolic isthmus), through which the superior mesenteric artery passes. At the beginning of the *third month* the U-shaped loop twists round on this isthmus from right to left (viewed from in front in the opposite direction to the hands of a watch, Fig. 5). By this twist the part of the hind gut near the limb of U is carried upward and to the left toward the splenic region where it adheres and forms the splenic flexure of the colon. The rest of the colon proximal to this swings over the front of the abdominal cavity from left to right, becoming attached to the structures on the posterior body wall along a line extending from the left to the right kidney and thence down to the right iliac fossa. As the twist affects both limbs of the U loop at the isthmus, the proximal part of the mid gut entering the loop is carried to the left behind the colon, and the rest of the loop twists in the same direction, so that it comes to lie free in the abdominal cavity below the colon with its mesenteric faces partly reversed, the *anterior face* of the mesentery representing the *right*

Fig. 3. The above figure shows a condition frequently seen when the first few feet of the jejunum pass to the right. *j*, is on the commencement of the jejunum. The arrows indicate the direction of intestinal flow.

side of the dorsal mesentery and the *posterior face* its *left* side. At the same time the superior mesenteric artery comes to lie in front of the commencement of this part of the gut and marks the line of separation between the duodenum and jejunum. The effect of this twist is to carry the right side of the dorsal mesentery of the duodenum against the posterior body wall where it becomes attached. It will be evident on reflection that the rotation of the U-shaped loop of the intestine, followed by its adhesion to the posterior body wall, is responsible for the obliteration of the lateral spaces of the body cavity on both sides of the dorsal mesentery of the upper end of the fore gut (2d and 3d parts of duodenum). The splenic flexure of the colon comes to lie in front of the left kidney and the hepatic over the right, while the ascending and descending colons lie in the right and left flanks. Peritoneal adhesions form between the colon and its mesentery and the posterior body wall which fix the *left face* of the gut and mesentery to the parietal peritoneum. The *right face* of the mesocolon becomes the anterior face, which lies in the concavity of the free colonic loop. It is continuous along the line of the ileocolic artery with the right face of the mesentery of the small intestine. The process of fixation is probably exactly analogous to that occurring in inflammatory processes. In most cadavers irregular lines of union leaving numerous pockets and crevices can be seen along the outer sides of the ascending and descending colons. At the splenic flexure, the union is very firm, being strengthened by a special band of tissue which passes from the diaphragm and the tip of the eleventh rib to the gut (costocolic ligament). Proximal to this the fixation is less substantial. The attachment of the transverse mesocolon to the pancreas and the second part of the duodenum is comparatively loose and the long mesentery allows great mobility to the transverse colon. The hepatic flexure is more firmly fixed to the tissues in front of the right kidney but there is no strong ligament on this side analogous to that fixing the splenic flexure. The ascending colon and cæcum unite fairly firmly with the posterior body wall below the right kidney. A careful examination of Figure 6 shows the anatomical relationships of the colon when complete rotation and fixation have taken place. The termination of the duodenum shows through the root of the transverse mesocolon. The small intestines have been removed and the cut edge of the mesentery is exposed along the line of the ileocolic artery. The ascending and transverse mesocolon form a roughly triangular area bounded by the ascending and transverse colon and the line of the ileocolic artery. The exposed face of the mesocolon is the original right face of the mesentery of the unrotated gut. Behind the termination of the duodenum lies the fossa duodenojejunalis, the extent and shape of which varies within great limits. Hernia into this fossa is occasionally met with. If the hernia passes to the left (the commonest variety) the inferior mesenteric vein and left colic artery lie in front of the neck of the sac. If the hernia passes to the right, the superior

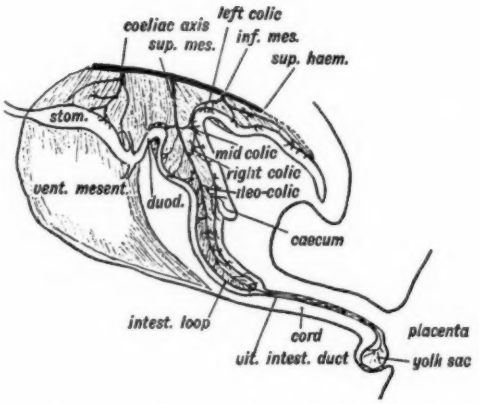

Fig. 4. Human alimentary canal in the fifth week of embryonic life. (Diagram from Keith.)

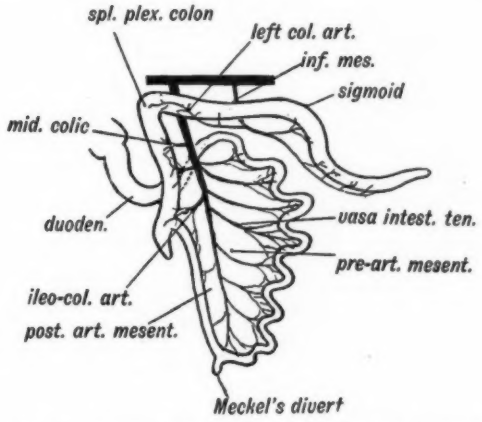

Fig. 5. Human alimentary canal in the third month of embryonic life. (Diagram from Keith.)

mesenteric artery lies in front of the neck. A successful case was operated on in the Sealy Hospital clinic where the hernia passed to the right. At least half the small intestine was found in the sac. The extent of the sac corresponded to a space roughly triangular in outline, bounded by the lines of the ascending colon and hepatic flexure, by the curve of the duodenum and by the line of the ileocolic artery. The ileocolic junction, cæcum, ascending colon with hepatic flexure and the third part of the duodenum were spread on the anterior surface of the hernial sac, along its boundaries. The mesocolon and the colic arteries were directly in front.

In order to make the above description still clearer, the attached figures taken from Huntington are exhibited.

Figure 7 shows a condition of complete non-rotation of the intestine. The cæcum and appendix are in the embryonic position. The small intestine lies entirely on the right side of the abdominal cavity, and the exposed face of its mesentery is the original left face. The part of the colon corresponding to the splenic flexure is well fixed and reasonably high. Between it and the cæcum, the colon is thrown into redundant folds. Between it and the rectum the descending colon passes downward as a straight tube.

Figures 8 and 9 show a condition of arrested rotation. The cæcum is at a very low level. The splenic flexure is high up and firmly attached. The small intestine lies entirely on the right side of the abdominal cavity. The exposed face of its mesentery is the original left face. The ileum enters the cæcum from right to left. In Figure 9 the small intestines have been pulled to left to expose the right side of the mesentery and to show that no adhesions have formed between it and the body wall.

Figure 10 shows the intestines of Tamandua bivittata (the little ant-eater) which exhibits a normal condition of non-rotation.

In all these examples the colon and the duodenum are separated by a narrow neck of mesentery across which strong transverse bands of tissue can be seen coursing. This neck represents the duodenocolic isthmus and through it the superior mesenteric artery passes. These conditions are very similar to that present in a human embryo of *five weeks*. It would seem to be an easy matter for rotation to occur around the narrow duodenocolic isthmus. Some cases of complete volvulus of the small intestine have been described which were probably examples of this. One such occurred in my practice where the whole intestine was twisted from left to right through one and a half turns.

In Figure 11 we have shown an example of arrested rotation. Here the small intestine

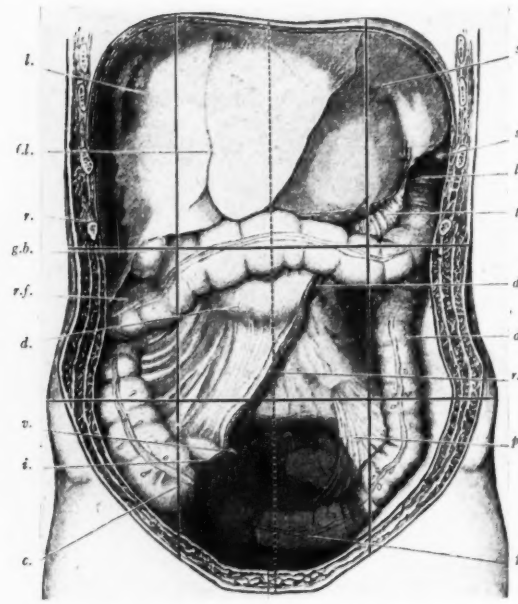

Fig. 6. *l.*, Liver; *f.l.*, attachment of falciform ligament; *r.*, tenth rib; *g.b.*, gall-bladder; *r.f.*, right flexure of the colon (O. T. hepatic flexure); *d.*, duodenum; *v.*, vermiform process; *i.*, ileum; *c.*, cæcum; *s.*, stomach; *sp.*, spleen, anterior angle; *l.f.*, left flexure of the colon (O. T. splenic flexure); *t.m.* tranverse mesocolon; *d.c.*, descending colon; *r.m.*, root of mesentery, cut; *p.m.*, pelvic mesentery; *p.c.*, pelvic colon. (From Cunningham.)

has completed its rotation to the left behind the large intestine and it lies in the left part of the abdominal cavity. Most of the large intestine has also rotated. The ascending colon and ileocolic junction have failed to rotate and as a consequence the terminal part of the ileum lies in the right iliac fossa to the right of the cæcum and turning downward to the left to enter it. In Figure 12 rotation of the whole intestine is complete except that of the cæcum. The ileum opens into its lower border. The iliac fossa is empty.

The two conditions last described are so frequent that scarcely a week passes without one or other being observed in our clinic. They are of little pathological interest and, apart from the fact that they make the search for the appendix more difficult, are of no consequence.

The remainder of my address will be devoted to the consideration of cysts of the neck of branchial origin with especial reference to the origin of ranula and cysts of the submaxillary region. A satisfactory classification of cysts of the neck is the following:

1. *Lymphatic cysts* (*hygroma colli*). They are usually situated in the lowest part of the posterior triangle of the neck. Not unfrequently they extend under the clavicle into the axillary space. They are derived from the lymphatic sinus (jugular sinus) which is present in the third month of fœtal life in the angle between the jugular and subclavian veins.

2. *Thyroglossal cysts.* They occur in the middle line of the neck either above the hyoid bone in the substance of the tongue (lingual cysts) or below the hyoid bone under the deep fascia. They are derived from the thyroglossal duct, which is formed by a bud of hypoblast which grows downward between the mandibular and pharyngeal parts of

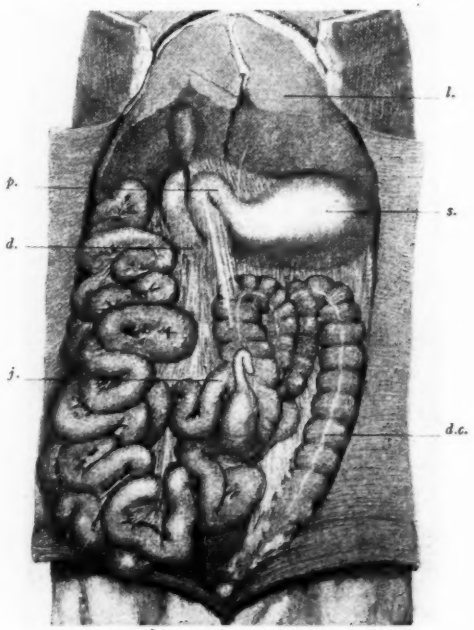

Fig. 7. Complete non-rotation of intestine. *p.*, Pylorus; *d.*, duodenum; *j.*, ileocolic junction; *l.*, liver; *s.*, stomach; *d.c.*, descending colon. (From Huntington.)

the tongue and which eventually forms the isthmus of the thyroid body and parts of the lateral lobes.

3. *Thyroid gland cysts.* They occur in the lateral lobes of the thyroid gland and are derived usually from cystic degeneration in adenomata arising from the gland.

4. *Sequestration dermoids.* They are usually found in the middle line and are derived from inclusion of areas of epiblast during the fusion of the ventral folds of the embryo.

5. *Branchiogenetic cysts.* They are derived from persistent remains of the external branchial depresssions of the embryo.

6. *Parastic cysts.* Echinococcus, etc

Branchiogenetic cysts In order to understand the source of cysts of branchial origin it is necessary to have a clear idea of the structure and ultimate fate of the branchial arches and clefts in the human embryo. In the *third week* of fœtal life evidences of branchial arches are visible in the human embryo. The pharyngeal region resembles that of an adult fish. Both have branchial arches, but whereas in fishes the arches are separated by clefts, in the human embryo they are separated by depressions. The depressions, which are visible on the outer aspect of the neck and the inner aspect of the pharynx, are separated by a membrane which is covered on its outer side by epiblast and on its inner side by hypoblast. In the normal course of events this membrane never disappears in mammals. In the rare instances in which it is perforated, a complete cleft results which may persist in the adult as a branchial fistula. The growth of the region of the neck in a human embryo is so rapid that by the end of the *sixth week* all external evidence of the branchial arches and depressions has vanished.

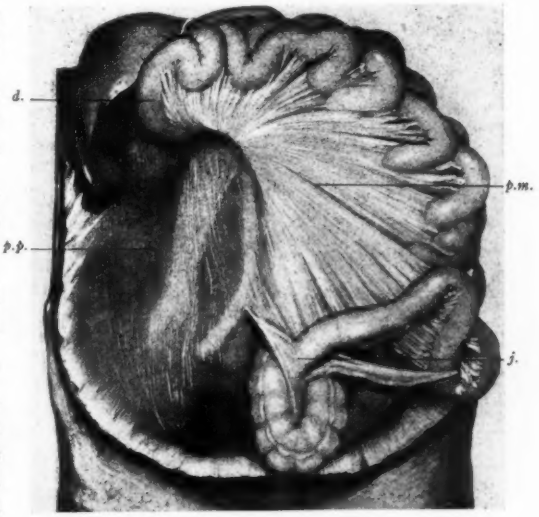

Fig. 9. Same case as Fig. 8, showing small intestines pulled to the left side. *d.*, Duodenum; *p.p.*, primitive parietal peritoneum of right lumbar region; *p.m.*, primitive mesentery common to small intestine and non-rotated colon; *j.*, ileocolic junction, dorsal surface. (From Huntington.)

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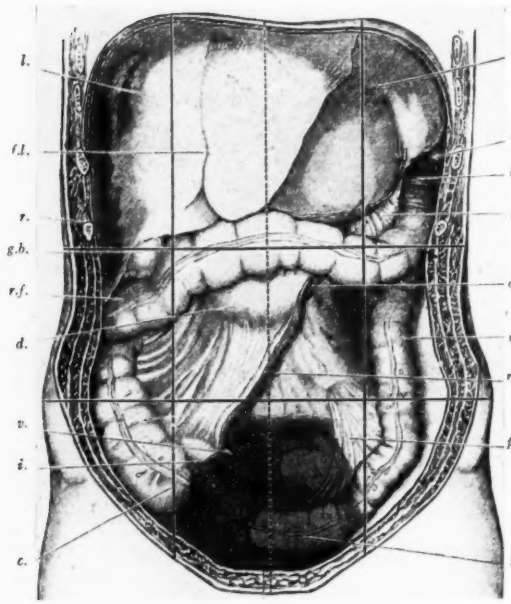

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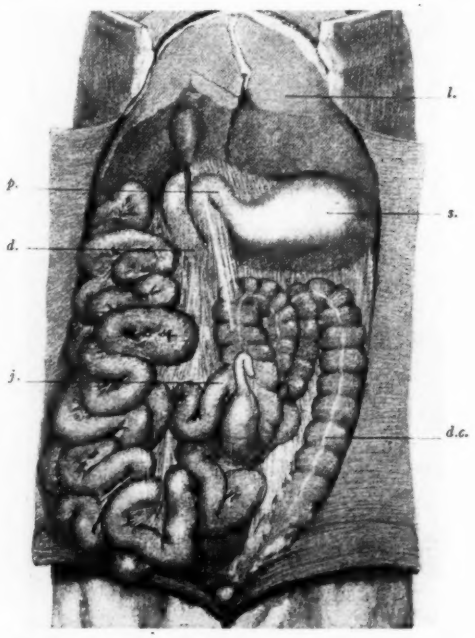

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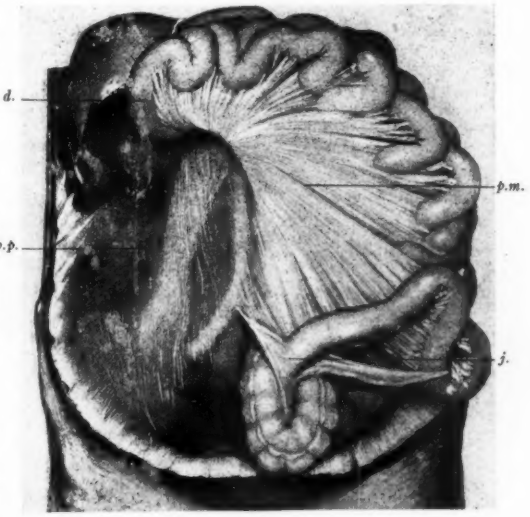

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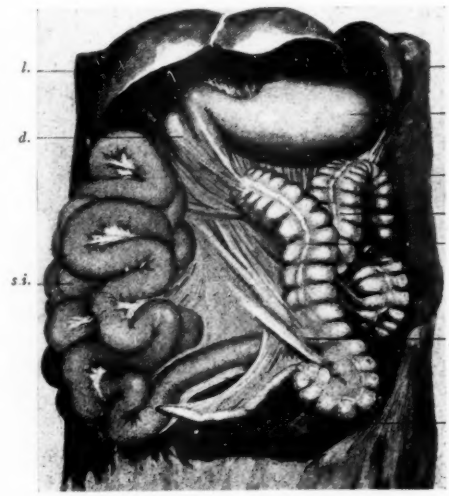

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Fig. 10. Intestines of Tamandua bivittata (little ant eater) showing a normal condition of non-rotation. *p.*, Pylorus; *d.*, duodenojejunal transition; *s.i.*, small intestine forming efferent limb of intestinal loop; *j.*, ileocolic junction; *g.o.*, great omentum turned up; *sp.*, spleen; *a.*, superior mesenteric artery in duodenocolic isthmus; *c.*, colon at termination of afferent limb of intestinal loop; *p.c.*, colon—proximal segment forming afferent limb of intestinal loop. (From Huntington.)

cartilage, (2) a vascular arch, (3) nerves, (4) muscle elements.

The first arch is the mandibular. Its cartilaginous basis (Meckel's cartilage) forms the foundation of the lower jaw, although the greater part disappears. The posterior end persists as the malleus, the anterior end as the part of lower jaw which carries the incisor teeth. The nerve of this arch is the third division of the fifth. The artery of the arch disappears, but the origin of the external maxillary artery (facial) marks the place where it arose from the ventral aorta (external carotid).

The second arch is the hyoid. Its posterior end persists as the stapes, the middle portion as the styloid process and stylohyoid ligament, and the lowest part as the lesser cornu of the hyoid bone. The nerve of this arch is represented by the facial and auditory (seventh and eighth). The artery of the arch disappears but the lingual artery marks the place where it arose from the ventral aorta.

The third arch is represented in the adult by the great cornu and body of the hyoid bone. Its nerve is the glossopharyngeal (ninth). The artery of the arch persists as the first part of the internal carotid. The superior thyroid artery arises from its place of origin from the ventral aorta.

The fourth arch is represented in the adult by the upper part of the thyroid cartilage. Its nerve is the superior laryngeal branch of the vagus. The vascular arch is represented on the right side by the first part of the subclavian artery, and on the left side by that part of the arch of the aorta between the origin of the left carotid and the spot where the ductus arteriosus enters it.

The fifth arch is represented in the adult by the lower portion of the thyroid cartilage. Its nerve is the inferior laryngeal branch of the vagus.

The sixth arch is represented in the adult by the cricoid and arytenoid cartilages, and the cartilaginous rings of the trachea and bronchi. Its nerve is the inferior laryngeal branch of the vagus. (The vasuclar arches of the fifth arch probably disappear early. That of the sixth persists on the left side as part of the right pulmonary artery and ductus arteriosus; on the right side it shares in the formation of the right pulmonary artery.)

The *muscles of the arches* deserve special consideration. Their embryonic origin is identified by their nerve supply. From the *first arch* (fifth nerve) are derived the muscles of mastication, the tensor palati and tympani, the mylohyoid and the anterior belly of the digastric; from the *second arch* (seventh nerve) the stapedius, the stylohyoid, the posterior belly of the digastric, all the muscles of facial expression and the platysma; from the *third arch* (ninth nerve) the stylopharyngeas and some of the muscles of the soft palate; from the *fourth arch* (superior laryngeal nerve) some of the muscles of the soft palate and the constrictors of the pharynx

and the cricothyroid; from the *fifth arch* (inferior laryngeal nerve) the intrinsic muscles of the larynx.

With the increase in length of the neck of the embryo, the arches descend and carry their muscular and nervous elements with them. The descent of the muscles is, however, not always quite regular, for we find in the soft palate one of the muscles (the tensor palati) supplied by the nerve of the first arch, and the rest supplied by a plexus (pharyngeal) in which the nerves of the third and fourth arches mingle. The greatest irregularity is seen in the muscles derived from the second arch (hyoid). A remarkable muscular bud makes its appearance, which grows upward into the face and scalp and downward into the lower portion of the neck (Fig. 13). From it the occipitofrontalis, all the muscles of expression and the platysma are derived. Branches of the seventh nerve are carried with the muscles.

Another muscular migration that further disturbs the orderly arrangement of parts comes from the seventh, eighth, and ninth body segments, which are situated behind those supplied by the tenth and eleventh nerves. These segments are supplied by the twelfth nerve (hypoglossal). The path and

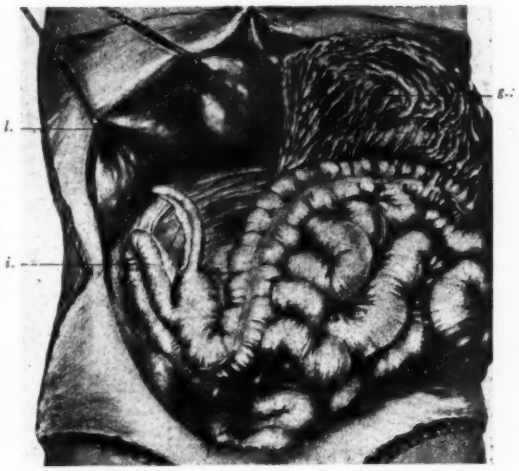

Fig. 11. Arrested rotation of intestine. *l.*, Liver; *i.*, terminal ileum; *g.o.*, great omentum. (From Huntington.)

extent of this migration is clearly shown by the course of the hypoglossal nerve and the situation of the muscles supplied by it (Fig. 14). It may be divided into two parts: an upper (ligula) which forms the geniohyoid, geniohyoglossus, hyoglossus and all the intrinsic muscles of the tongue, and a lower (infrahyoid) which forms the depressors of the hyoid bone. One of the muscles, viz.: the omohyoid, passes down as far as the scapula. The lingual bud (Fig. 15), into which the upper part of this muscular mass penetrates, is developed from two separate parts, an anterior (buccal) which arises from the anterior ends of the first visceral arch, and a posterior (pharyngeal) which arises from the anterior ends of the second and third arches. The hypoblast of these buds retains its original nerve supply. That to its anterior part, which forms the anterior two-thirds of the tongue, comes from the nerve to the first arch (fifth-lingual) while that to the posterior which forms the posterior third of the organ is derived from the nerves of second and third arches and is represented by the chorda tympani (seventh) and the glossopharyngeal (ninth). The resulting organ offers an interesting picture of a muscular mass innervated by the twelfth nerve and

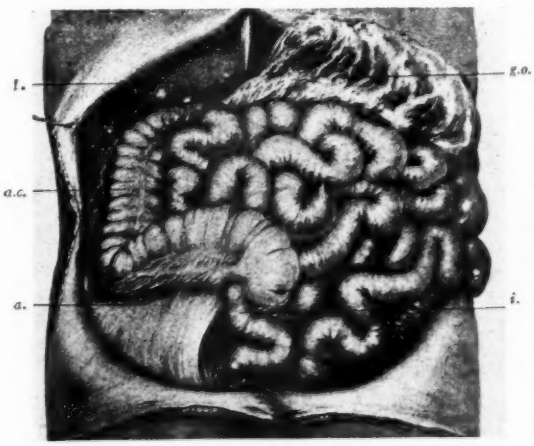

Fig. 12. Arrested rotation of intestine. *l.*, Liver; *a.c.*, ascending colon; *a.*, appendix adherent to lateral aspect of ascending colon and to iliac parietal peritoneum; *g.o.*, great omentum; *i.*, terminal ileum. (From Huntington.)

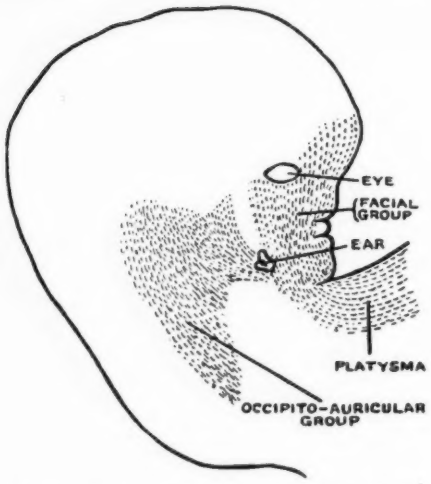

Fig. 13. Migration of platysma. (From Keith.)

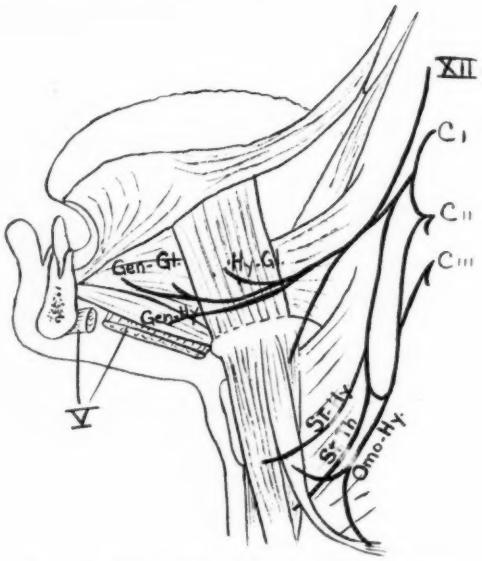

Fig. 14. Migration of muscles of hypoglossal group.

covered by mucous membrane supplied by the fifth, seventh, and ninth nerves.

Branchial clefts. Four cleft depressions can be recognized in the embryo. The first cleft (hyomandibular) persists. Its external depression is represented by the external auditory meatus. In connection with the internal depression the eustachian tube and tympanum are developed. The membrana tympani represents probably the cleft membrane. The second, third, and fourth clefts disappear and usually leave no traces. In a very young embryo (fourth week) the second arch grows downward and covers the third and fourth and comes into contact with the body wall behind the fifth. By this growth, which is analogous to that forming the gill cover in fishes, the orifices of the second, third, and fourth cleft depressions are covered up, and a space is shut off into which they open. This is called the cervical sinus (Fig. 15). It usually disappears. If it persists a cyst may result. The cyst may open externally on the neck and the usual situation of the opening is in the lower part of the neck along the anterior border of the sternomastoid muscle. Occasionally the cyst opens internally into the pharynx. When this occurs the opening into the pharynx usually passes through the membrane of the second cleft. When both internal and external openings are present a long fistulous tract lined by epithelium stretches between the surface of the neck and the cavity of the pharynx (Fig. 16). If the tract is dissected out it always passes above the fork of the carotids, i. e., above the third brachial arch. The internal opening is in the tonsillar recess. (*Second cleft depression.*) The external opening varies in position. It is always along the anterior border of the sternomastoid, but it may be anywhere between the cricothyroid space and just above the sternoclavicular joint.

It is difficult to determine the part played by the cervical sinus in the formation of branchial cysts. It is more than probable that it is responsible for the cysts and fistulæ met with in the lower part of the neck below the level of the thyroid cartilage. But it is more difficult to understand how cysts situated high up in the neck under cover of the parotid gland can be derived from a cavity which primarily covers the second, third, and fourth clefts. If, however, we admit the possibility of such a cyst being carried from a lower to a higher level by muscular agency

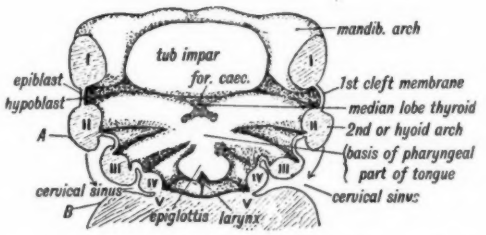

Fig. 15. View of the inner aspect of the pharynx showing the anterior ends of the branchial arches and the internal branchial cleft depression. (From Keith.)

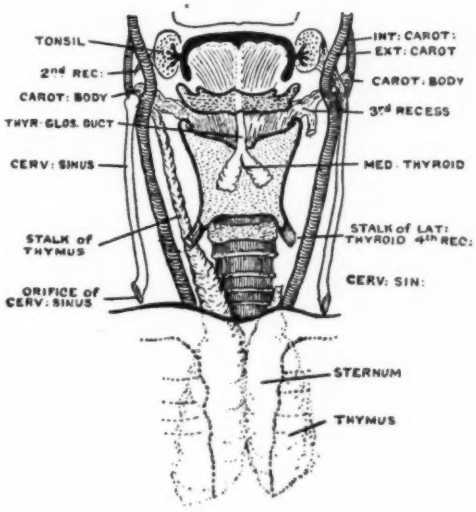

Fig. 16. Diagram showing in schematic fashion the cervical sinus and the organs developed in connection with the inner branchial cleft recesses. (From Keith.)

in the rearrangement of the muscular planes of the neck, the problem is easily solved. After careful deliberation I have adopted this theory as a satisfactory explanation of mucous cysts of the upper cervical region. I shall include ranula in this category; and while I hesitate to state dogmatically that true ranula always has its origin in branchiogenetic rests, I am able to present strong clinical and pathological evidence in support of this contention.

In 1906, I reported two cases of congenital cysts of the neck, with mucous contents, which I believed were derived from branchial clefts.[1] In both cases the anatomical relationships of the cysts with the deep structures of the neck were identical, and at the same time so peculiar and definite that they negatived mere coincidence as to origin. I have since seen other cases with features so identical that a common description will serve for all.

The cysts lay in the upper part of the neck, beneath the deep cervical fascia, under cover of the upper part of the sternomastoid muscle and the lower part of the parotid gland. In none of the cases did it extend into the neck lower than the hyoid bone. In all the cases there was a narrow communication between the main body of the cyst and a similar cyst in the submaxillary region. In three of the cases the submaxillary portion of the cyst communicated around the posterior border of the mylohyoid muscle with a cyst in the floor of the mouth underneath the tongue (ranula). In the one case there was no ranula but an accessory cyst was found medial to the submaxillary portion of the cyst. The cases are represented diagramatically in Figure 17.

The following description of one of the cases associated with ranula is taken almost verbatim from my original report (Case 1). It is entirely satisfactory even at the present time and my subsequent experience has corroborated the accuracy of the original anatomical description.

The first case was that of a young girl, L. S., age 15, who was sent to me, in March 1904, by Dr. Nixon, of Gonzales, for diagnosis and treatment. The family history showed nothing pertinent to the case. Personal history was of little consequence. She had suffered from most of the diseases of infancy except measles. She had always been strong and healthy.

In November, 1902, the patient first noticed a small swelling underneath the tongue. It gave no trouble, but worried her. She consulted a physician, who incised it and evacuated a little white mucus. After a time it reappeared, and although evacuated from time to time, the mucus reaccumulated. A seton was inserted, but with no effect. In January, 1903, she consulted Dr. Herff, who pronounced it a ranula, and attempted the removal. The condition was better for a time. Her mother kept the opening into the cyst patent until May, 1903. In September, 1903, the condition became worse again, and the swelling involved the tissues under the jaw; the tongue was badly swollen, and

[1] Texas St. J. Med., 1906, Dec.

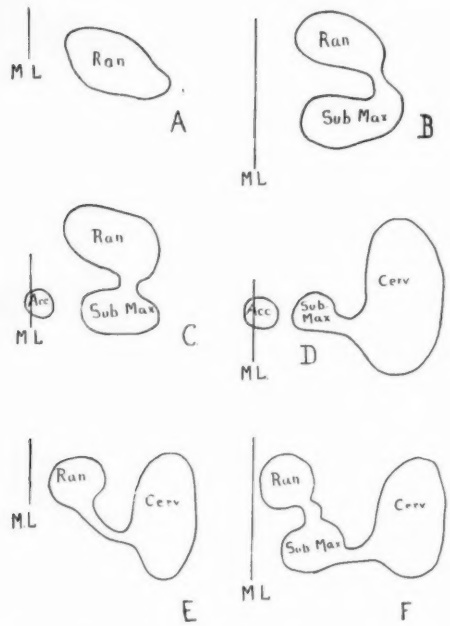

Fig. 17. Types of cysts found in lingual submaxillary cervical regions. For convenience they have all been placed on the left side. *ml*, Middle line of body. *ran*, Ranula. *sub-max*, Submaxillary cyst. *cerv.*, Cervical cyst. *acc*, Accessory cyst.

the upper part of the anterior triangle of the neck was bulged. Dr. Herff drained it again with temporary improvement. In October it swelled up again and the parotid gland became more prominent. A rubber drainage tube was used, and retained for 7 weeks. In January the swelling reappeared, and intermittently increased and decreased in volume until March 1, 1904, when she consulted me. The condition was the following: Under the right side of the tongue a typical ranula, the size of a walnut could be seen, on the surface of which appeared a scar passing horizontally from right to left. Wharton's duct had been divided and the secretion of the right submaxillary gland exuded from its cut proximal end. The tongue was pushed upward and to the left and speech was indistinct. Below the body of the jaw, the upper part of the submaxillary region bulged slightly, this swelling being apparently continuous with that underneath the tongue. The parotid gland was a shade more prominent on the right side than on the left.

On March 4, I operated on the ranula and attacked it at first within the mouth. Finding that complete removal would be impossible by the intrabuccal method, I opened the submaxillary region, by the incision usually used to tie the lingual artery. The ranula was situated for the most part above the mylohyoid muscle, but a process extended down around the hinder border into the submaxillary triangle almost as far as the hyoid bone. To reach it the submaxillary salivary gland was dislocated upward. While dissecting the lower part of the cyst away, mucus was seen to ooze from the posterior part of the wound. A director, passed toward this point, suddenly penetrated along a narrow channel into a large cavity from which mucus exuded. The channel was dilated, and the exploring finger passed into the cavity. It was quite large, and at its highest point, the tip of the finger was just able to feel the boundary wall. The boundaries were the following: Above, it reached the base of the skull, the bony irregularities of which could be distinctly felt. Behind, the anterior border of the mastoid process and the whole length of the styloid process could be felt so distinctly that the velvety cyst wall appeared as thin as the thinnest rubber finger cot. Mesially the bodies of the upper cervical vertebræ were distinctly made out. The carotid artery could be felt beating under the posterior lining of the cyst. Anteriorly and internally were the tonsil and pharynx. Externally was the ramus of the lower jaw covered by the internal pterygoid muscle; also the parotid gland. Below, the cyst terminated in a rounded outline, the lowest part being about the level of the body of the hyoid bone.

The cases that have been observed since have conformed in every detail to the description given above as regards the anatomical situation of the deep cervical part of the cyst. There has been considerable variation in the way they connected with the cysts in the submaxillary region or with those underneath the tongue. They are represented with fair accuracy in Figure 17, *D*, *E* and *F*.

Microscopic examination of the lining wall of the cysts was rather unsatisfactory. Most of the sections showed no epithelium. Where epithelium was found it occurred as a single layer like that lining the interior of a blood-vessel. The connective tissue beneath the endothelium was a thick layer of dense fibrous tissue with large lymph spaces. It was remarkably free from cellular elements.

It is strange that after a careful search through the literature of the subject I have been unable to secure histories of cases of ranula and branchiogenetic cysts that correspond exactly with those just described. Their anatomical boundaries are so definite and consistent as to negative mere coinci-

dence, and to support the view that they are probably of frequent occurrence.

It seems a far cry from simple cases of ranula to the complicated cysts that we have just described. If, however, a careful analysis is made of the topography of cysts in the floor of the mouth and submaxillary region that most surgeons would admit without hesitation as ranulæ, we can supply the missing parts of the puzzle. In Figure 17, *A*, *B*, *C*, *D*, *E* and *F*, six varieties of cysts are pictured, each of which is an accurate representation of an individual case verified by operation. The explanation is given in the attached legends. The inference that each one of these varieties represents isolated and scattered parts of a mother cyst that has been subjected to fragmentation and displacement is irresistible. No satisfactory evidence has ever been advanced that ranula arises from mucous glands in the floor of the mouth or from the salivary glands; and the theory of its development in a bursa (Fleischmann's) has still less to support it.

Therefore, after careful deliberation I advance the theory that ranula, submaxillary cysts, and deep cervical cysts of the types presented are derived from vestigial remains of the branchial clefts; that the primary cyst is derived from the cervical sinus or from the parts of the cervical sinus in relation to the external depression of the second cleft; that the cyst is carried from its original position by the shifting of muscles during the formation of the neck, by which part of the cyst (deep cervical) is carried up to the base of the skull by the palate muscles which are derived from the third and fourth arches, and part carried into the submaxillary region and tongue by the migration of the muscles of the hypoglossal group.

The theory is suggested with considerable hesitation because I feel that it is supported by a somewhat slender array of clinical observations; but its simplicity is so apparent—and simplicity is so often the greatest attribute of truth—that I venture to submit it for your consideration and criticism.

ICTERUS IN ECTOPIC GESTATION

Modes of Jaundice Production[1]

By EDGAR H. NORRIS, M.D., St. Paul, Minnesota

THERE probably is no other common clinicopathological entity which confronts the student of female pelvic disease with so wide a range of differential diagnosis, and at the same time incurs such responsibility for the immediate recognition of the condition, as does ectopic gestation. The literature which this interesting and important subject has brought into being is large, and many of the studies are classical. Many of our conceptions in this regard are centuries old, and it cannot be considered strange that the ideas of the profession on a subject the earliest records of which date to an era so far removed as the tenth century, should be pretty well fixed and that the recent advances in our knowledge should be few. It is not at all the author's purpose in the present writing to review the extensive literature on ectopic gestation, but simply to present two cases of considerable interest and to attempt to emphasize certain features in the differential diagnosis.

Case 1. Mrs. H. L. R.; housewife; age 23; complains of severe cramp-like pains in the lower abdomen. The patient has always been healthy. The history reveals no previous diseases, but the patient thinks she is a little over-nervous. She is not constipated; the bowels move every day. Of late the patient says she has felt nauseated in the morning but has not vomited. For past 3 to 4 years she has had to urinate 10 to 12 times daily and 3 to 4 times at night. The urine burns her at times. It is of a light color. Says she does not suffer excessive thirst and does not drink much water. She has had no leucorrhœa and no yellow discharge.

Her menses began at the age of 13; the periods were regular, of the 28-day type, of 3 to 4 days' flow, and were without pain. The flow was moderate, most on second day. Her last menstruation was on July 13, 1918 (43 days ago). This last period was quite like her usual periods. The patient was married 14 months ago. The husband is living and well. The patient has never been pregnant; she desires children.

Last Friday (August 23, 3 days ago) at 4:00 p.m., while the patient was ironing she was suddenly attacked with a severe sweating spell which was immediately followed, and then accompanied by intense, cramp-like pain in the lower abdomen. The patient had to sit down even before the cramps came on because she was so weak and felt as though she would faint. She went to bed for a few minutes but was taken with another spell of pain as soon as she got up. She remained in bed for the rest of that night and Saturday morning. Upon getting up on Saturday afternoon, she was again taken with another attack of pain, profuse sweating, and faintness. She was nauseated but did not vomit. Saturday evening she suffered a third attack and vomited much with it. The patient rested well Saturday night, and stayed in bed until Sunday afternoon. She says her abdomen was very tense and hard. On Sunday evening the patient noticed that her eyes, face and hands were very yellow, and she vomited a yellowish material. She also noticed that her urine was unusually deeply colored. Sunday evening she had a very slight blood stained discharge from the vagina. While she was walking about on Monday she had considerable abdominal pain. She states that for the past week she has noticed that her breasts have been increasing in size and firmness and also that the follicles (montgomerian) have become prominent.

Physical examination. General: The patient is a well developed, well nourished young woman, who lies quietly in bed and appears to suffer no discomfort. The scleræ and the general cutaneous surface show a well marked icterus. The mucous membranes are slightly pale. The pulse is a little rapid (100 per minute), but its quality is good. Oral temperature is 99.4° F. The examination of the head, neck, thorax, and extremities reveals nothing of importance in connection with the present illness. The abdomen is rather full and protuberant but not distended. There is considerable fat in the abdominal wall. The musculature is of good tone, but there is no rigidity or muscle spasm. Deep palpation over the lower abdomen elicits some tenderness. No masses are palpable. The liver extends to the costal margin (by percussion), but neither it nor the spleen can be palpated. There is no tenderness over these organs.

Bimanual examination. The introitus shows no inflammation or discharge. The urethra shows Skene's glands slightly enlarged. The mucous membrane of the vagina is pink in color, no congestion is present, but there is some thin white discharge. The cervix points downward, forward, and slightly to the left, is somewhat enlarged and softened at its tip, is not tender, is movable and bluish in color. The external os is round and will not admit the finger; thick, mucoid secretion coming from cervical canal. The corpus shows first degree retroversion;

[1] Read before University of Minnesota Pathological Society, April 21, 1920.

is very slightly enlarged; symmetrical; regular in outline; no change in consistency can be made out; not freely movable; movement causes slight pain. The adnexa on the right show no palpable masses; no tenderness; on the left, there is a soft, tender, spindle-shaped mass, the size of an egg, slightly movable, located in the left side of the uterovesical pouch. The parametria shows no infiltration; no tenderness.

Clinical pathology. The urine is of amber color; reaction is acid; specific gravity is 1012; no albumin; no sugar; no casts; no red blood cells.

Blood examination shows hæmoglobin 75 per cent, erythrocytes 3,200,000, leucocytes 9,000, polymorphonuclears 60 per cent, lymphocytes 23 per cent, large mononuclears 6 per cent, transitionals 2 per cent.

Diagnosis: ectopic gestation with rupture.

Operative findings. The abdomen was opened by a mid-line incision and the presence of fluid blood in the peritoneal cavity was recognized. In all there was approximately 500 cubic centimeters of blood present. The left fallopian tube was enlarged to the size of a small lemon and the enlarged portion was fusiform in shape. The tumor mass was soft in consistency and dark red in color. The left ovary was enlarged and there was present a corpus luteum about 1 centimeter in diameter. The left tube was removed and a pregnancy found. The blood was sponged out of the pelvis and the general abdominal cavity and the usual closure made.

The patient remained in the hospital 14 days following the operation, during which time she made an uneventful recovery. *On the third day following the operation the icterus had quite disappeared.*

CASE 2. Mrs. M. B., telephone operator, age 25, complains of severe cramp-like pain in the lower abdomen; metrorrhagia and menorrhagia.

The patient was never strong as a girl. She grew very slowly until 14 years of age. She has had varicella, variola, diphtheria, mumps, measles, pertussis, influenza, inflammatory rheumatism and erythema nodosum. The bowels tend to be constipated. She urinates 3 to 4 times during the day and not at all at night. A burning sensation accompanies urination. She has had leucorrhœa ever since menstruation began, and about 2 years ago the discharge became yellow and stained her garments. This discharge did not burn her or cause soreness, but was followed by frequent, burning urination. Six months ago the patient was in the Minneapolis City Hospital with erythema nodosum and at that time gonococci were found in the vaginal discharge, but no masses or tender regions were located in the pelvis. The patient left the hospital about 5 months ago and had no further trouble until the onset of the present illness. Appendectomy for chronic appendicitis at 18 years of age.

The menses began at the age of 12. After a few periods she stopped flowing until she was 14. The periods were of the 28-day type, lasting 8 to 10 days. The flow was profuse; but was associated with no pain in recent years although she had much pain before marriage and until after the last child was born. The periods were regular up to the onset of the present illness, except during the time of pregnancy and lactation.

The patient has been married 7 years. The husband is living and has gonorrhœa. The patient is not living with her husband at present. She had extramarital intercourse 3 months ago. She has two children, 6 and 4 years old. Two years ago she had an induced abortion at about two months' gestation, which was followed by "blood poisoning." With this illness the patient was in bed 4 weeks, with fever, chills, and delirium.

About two months ago the patient began to have pain in the right side of her lower abdomen. There was a slight show of blood preceding this pain and antedating her regular period by several days. At this regular period the flow was excessive and clots were passed. Following this period she was suddenly seized with a severe cramp-like pain which lasted for several hours and made her go to bed. The patient missed her last regular period and began flowing profusely 5 days later, and the flow has continued for the past 10 days up to the present time. The patient says she has experienced no fainting spells with any of these attacks of pain or external bleeding although she has felt weak. A little less than 2 weeks ago, the patient noticed that her skin and her eyes were turning yellow. The yellow color quickly became well marked and remained so until admission to the hospital. There were no clay-colored stools—patient says they were brown in color. The patient has not been nauseated, nor has she vomited in the present illness. She says there has been no recent change in the size or firmness of her breasts. The patient does not think she is pregnant.

Physical examination. General. The patient is a well developed, fairly well nourished young woman, whose face is drawn and wears an anxious expression. The scleræ and general cutaneous surface show a well marked icterus. The mucous membranes are red in color. The pulse is increased in rapidity (112 per minute), but its quality is good. Oral temperature is 102° F. The examination of the head, neck, thorax, and extremities reveals nothing further of importance in connection with the present malady. The abdomen is not distended or scaphoid but rather flat; the skin is yellow like that of the rest of the body; no eruptions; numerous old striæ gravidarum; old healed surgical scar in the right lower quadrant. The abdominal wall is rather lax, especially in its upper part. There is no rigidity or muscle spasm on light palpation. Over the lower abdomen there is no superficial tenderness, but deep palpation elicits marked tenderness and definite muscle spasm, especially on the right side. No masses are palpable. The liver extends to the costal margin (by percussion), but neither it nor the spleen can be palpated. There is no tenderness in the region of the liver or gall-bladder.

Bimanual examination. Introitus and external genitals are covered with freshly clotted and fluid blood. The urethra shows no discharge and no inflammation. Examination of the vagina shows the mucous membranes pink in color with no apparent congestion. The vaginal canal contains considerable bloody discharge and some blood clots. The cervix points downward and backward, is the normal size for a multiparous woman, has no apparent softening, no tenderness, is movable, and shows first degree bilateral laceration. A bloody discharge comes from the cervical canal. The position and outline of the corpus cannot be determined because of the marked tenderness in the pelvis. Both adnexal regions are very tender but no definite masses can be made out.

In the cul-de-sac of Douglas there is a semi-fluctuant mass, the size of a lemon. The mass is regular in outline, fixed, and exquisitely tender.

Clinical pathology. The urine is of amber color, reaction, acid; specific gravity 1018; no albumin, no sugar, no casts, no red blood cells.

The blood shows hæmoglobin 80 per cent, erythrocytes 4,600,000, leucocytes 30,700, polymorphonuclears, 88 per cent, lymphocytes 10 per cent, large mononuclears 1 per cent, transitionals 1 per cent.

Diagnosis: (1) Extra-uterine gestation with rupture. (2) Tubo-ovarian abscess.

The above conclusions were reached by the author in the receiving ward of the hospital. The patient was transferred to the Gynecological Ward where a diagnosis of "probable pelvic peritonitis" was made.

Operative findings. A posterior colpotomy was done and upon opening into the cul-de-sac old blood was found, and a wing tube inserted. Then the abdomen was opened by a mid-line incision and a ruptured ectopic pregnancy was found on the right side and a small tubo-ovarian abscess on the left side. Both tubes and ovaries were removed. In all there was something less than 500 cubic centimeters of free blood found in the abdomen. This blood was removed, and the usual closure made.

The patient developed a generalized peritonitis following the operation and died in 6 days. Notwithstanding this serious and fatal postoperative complication, *the jaundice had completely disappeared by the fourth day following the operation.*

In many of their clinical features neither of these cases is unusual, but the associated icterus gives to them both academic and practical clinical importance. Not only are the questions of the chemistry and pathogenesis of "jaundice" directly involved, but the problem of the differential diagnosis of ectopic pregnancy is intimately concerned.

The fact that the icterus developed shortly after the onset of local, pelvic symptoms in both cases, and the fact that in each the pigmentation disappeared directly after the operative interference can scarcely be interpreted otherwise than by assuming that the jaundice was the important symptom of the primary disease entity. After all, as has been so frequently pointed out before, jaundice is always only a symptom and should be given diagnostic importance only when it is regarded as an integral part of the symptom-complex in which it presents. It is, however, a symptom of no little importance and the presence of icterus no matter how slight in degree should be sought for, and when discovered, assigned to its proper place in the syndrome at hand.

In discussing the relation of icterus to ruptured ectopic pregnancy, there are several elementary concepts which must be borne in mind and certain fundamental questions which must be answered at the onset That the crystalline pigment—hæmatoidin—so frequently found in old extravasations of blood is chemically identical with bilirubin, the chief pigment of the bile, has been maintained by numerous investigators. Other workers have further demonstrated the very intimate relation between hæmoglobin and bile pigments, by showing that increased destruction of hæmoglobin leads quite directly to an increased formation of bile pigment. Hæmoglobin is thus the ultimate source of the bile pigments.

Wells (1918) says: "Pigmentation of the tissues of the body in jaundice depends upon the presence in them of bile pigments, which usually have been formed in the liver and resorbed either into the lymph or blood (or both). However, a pigment which seems to be chemically identical with bilirubin (hæmatoidin) may be formed from hæmoglobin liberated on the breaking up of red corpuscles, and possibly this may be produced in sufficient amounts outside of the liver to give rise to a general icterus. Certainly the local greenish-yellow pigmetation occurring in the vicinity of extravasations of blood, due to hæmatoidin formation may be looked upon as a 'local jaundice,' and in icterus hæmatoidin crystals may be found in the tissues."

This quotation from Wells expresses quite accurately the present generally accepted

belief in regard to the development of icterus and the relation of jaundice to extravasations of blood. It is interesting to note that since the first edition of his text (Wells, 1907) this author's ideas in regard to the relation between liver function and jaundice have changed somewhat. In this earlier publication he stated that hæmatoidin "is probably *never* formed in sufficient amounts outside of the liver to give rise to a general icterus."

In 1886 Minkowski and Naunyn demonstrated that in geese the production of hæmolysis by means of arseniureted hydrogen leads to icterus, but if the livers of the geese have been previously removed, no icterus follows the poisoning. From the time of these classical studies many workers have interested themselves in the problems associated with jaundice production and numerous studies have been completed. The results attained by some of these investigators are widely at variance, but on the whole it is believed that the pigments that produce the general discoloration of icterus are, at least in most part, manufactured in the liver. The chief differences of opinion seem to be in regard to the causes of the resorption of the bile from the liver into the blood. Much creditable evidence has been adduced to show that such factors as the low pressure of bile secretion, temporary increased biliary concentration leading to occulusion of the bile canaliculi, and swelling of the hepatic cells, are of certain importance. It seems very likely that these factors may all play a part, one possibly having greater importance in a given case than in another.

However, in 1913, Whipple and Hooper demonstrated experimentally by the intravenous injection of hæmoglobin, that jaundice can be produced in dogs whose livers have been isolated from the circulation. Moreover, as pointed out above, other workers have already indentified bilirubin in hæmorrhagic effusions located where the liver could have no influence.

Since a time very early in the history of scientific medicine, there have existed two different general ideas in regard to the etiology of jaundice. In one the condition has always been regarded as hepatogenous in origin; in the other instances have been taken into account which were considered hæmatogenous, i.e., developing irrespective of liver function. On the basis of the great mass of accumulated data which we possess today, it is necessary to agree with Joannovics (1904), who not only concluded that both the hepatogenous and hæmatogenous types exist, but even undertook to point out definite differences in the symptomatology of the two.

In 1914, Schottmuller presented a case of ectopic pregnancy which was accompanied by jaundice, and on the basis of this case he propounded a theory which seems quite untenable. His case gave the classical combination of symptoms for extra-uterine gestation and developed generalized icterus 24 hours following the onset of symptoms. Jaundice was still well marked on the fourth day, at which time clinicopathological studies showed: 2,200,000 red blood cells; 45 per cent hæmoglobin; no pigments in the urine; blood serum yellower than normal and containing much hæmatin. The general condition at this time was good. Three days later the general appearance was little changed, but the blood serum contained three times as much hæmatin as before and the urine contained much oxy- and methæmoglobin. The hæmoglobin in the blood had gone up to 50 per cent. Reasoning on the basis of this case, he concludes that since there was such a great increase of hæmatin in the blood serum with the simultaneous appearance of methæmoglobinuria, and without any subjective symptoms of new intraperitoneal hæmorrhage, that these abnormal pigments must have come, at least partially, from some source other than the original intraperitoneal blood. He suggests that an autohæmolytic substance may have been formed from the antigenic influence of the hæmoglobin-free portion of the extravasated erythrocytes, and he further proposes that this autohæmolytic substance not only hæmolized the extravasated red blood cells but probably affected also the erythrocytes in the circulating blood. Such a theory is quite valueless, for in the first place it is not supported by a careful analysis of the facts of the case whose features it has been invoked to explain, and in the second

place it is contrary to general physiological and immunological principles.

Coming now to apply these facts in the direct consideration of our own cases we find as premises of the problem (1) the presence of free blood in the peritoneal cavity; (2) forthwith, the development of generalized icterus; (3) the rapid disappearance of the jaundice following the removal of the hæmato-ascites.

The interrelation of these features both in fact and in time make the conclusion obvious that the jaundice resulted from the presence of the blood in the peritoneal cavity. How then was the icterus produced, through the function of the liver or otherwise? This question can be finally solved only by experimental study, but it seems to the author that it is unnecessary to hypothesize liver function as essential in this case. If the extravasated blood was rather rapidly broken down into hæmatoidin, it can readily be understood how the very ready absorption from the peritoneal cavity might result in a generalized dissemination of this pigment throughout the body.

When a hæmorrhage takes place, the extravasated blood is attacked by the hæmolysins and proteases of the leucocytes, tissue-cells and juices, and blood plasma. These separate the globin from the hæmatin or hæmochromogen. The hæmatin may then gradually undergo further changes with the formation of an iron-free pigment (hæmatoidin), and an iron containing pigment (hæmosiderin). If the hæmorrhages are very abundant, some hæmoglobin may be absorbed and appear in the urine as such.

Schurig (1898) found that hæmoglobin injected into the tissues is partly decomposed *in situ* with the formation of iron compounds, but the greater part enters the circulation as hæmoglobin, and is partly converted into bile-pigment by the hepatic cells, the rest being excreted as such or converted into iron compounds by the spleen, bone marrow, and renal cortex. On the other hand, if the hæmorrhagic extravasation into the tissues has been large in amount, the deeper parts of the hæmorrhagic mass are not soon, if ever, invaded by leucocytes, tissue cells, or fluids. In such a case the blood is acted upon very slowly by the enzymes liberated from its own leucocytes and by the small amount of protease in the serum. Furthermore, the products of decomposition are very slowly and incompletely absorbed, or may remain as crystalline deposits for long periods of time in the hæmorrhagic detritus.

Consequently we learn that the manner in which the body handles a hæmorrhagic extravasation does not adhere to any absolute rule, but varies widely with such factors as the site of the hæmorrhage, the size of the hæmorrhage, the availability of lytic substances, and the local provisions for absorption. Because of these many variants, considerable differences in the general and local effects produced by the absorbing hæmorrhage must be expected.

It seems reasonable then that free blood in the peritoneal cavity, in the presence of a strong lytic serum (or serum rich in protease) could be quickly split with the production of sufficient quantity of hæmatoidin, that the large and ready absorptive surface of the peritoneum might so charge the blood with the pigment as to give rise to a generalized icterus. The fact that some cases of intraperitoneal hæmorrhage do not give jaundice is well known and can readily be explained by reasoning in the opposite direction on the basis of the factors mentioned above.

The various pigments derived from hæmoglobin (hæmatin, hæmochromogen, hæmosiderin, hæmatoiden), differ from each other both chemically and also in their spectroscopic behavior. Each of these bodies is a colored substance and in this physical property each is very much like the other and the staining of the body tissues and fluids is, in most cases, not recognizably different. Any or all of these may circulate in the blood in varying amounts and the blood serum will be colored in shades from yellow to a deep brown by their presence. It is, however, impossible to indentify the exact pigments present without the aid of the spectroscope or other more accurate physicochemical tests.

So much for the theoretical and academic side of the problem. Whatever be the ultimate cause of the jaundice, the important clinical fact is simply to know that jaundice

may be a not uncommon, and ofttimes an extremely valuable symptom, in the differential diagnosis of ectopic pregnancy.

While discussing the question with a number of surgeons, it has several times been suggested that concomitant pelvic infection might be an explanation of the jaundice. This, however, does not seem to be a necessary corollary, for one of our cases was quite free from any pelvic infection.

In going through the English literature on extra-uterine gestation, the author has nowhere found mention made of this symptom except in De Lee's monumental work, where a single statement is included. In discussing hæmatocele, De Lee says: "Jaundice is an important sign, since it usually accompanies a degenerating blood clot." A consideration of our cases, however, will show that the symptom has even a greater importance than this quotation would seem to imply, for we have observed the icterus very early in the clinical course of the malady.

The great German texts on obstetrics seem nowhere to make mention of the symptom which the present paper presents. It is apparent therefore that this feature is not one of common knowledge. Schottmuller (1914) and Dick (1884) have reported four and two cases respectively, in which jaundice accompanied ectopic gestation as a symptom, and the former author strongly emphasizes its diagnostic importance.

Certainly whenever the possibility of extra-uterine pregnancy enters into the differential diagnosis the presence of icterus should be sought for and if found given its proper place in the syndrome at hand. Not only should the clinical presence of jaundice be looked for, but a specimen of blood serum should be examined, both grossly and with the aid of the spectroscope. In these cases much more valuable information may be gained in this way than by the usual routine examination of the blood. We must conclude, therefore, that jaundice may not uncommonly be a symptom of considerable prominence in ectopic gestation, and may even be the feature which determines the differential diagnosis.

SUMMARY

1. Jaundice is a not uncommon symptom of ectopic gestation.

2. The presence of jaundice is of great importance and may frequently be the symptom which determines the differential diagnosis.

3. The jaundice in these cases is probably due entirely to the absorption of blood-derived pigments produced by the hæmolysis of the extravasated blood.

4. The blood serum often contains considerable quantities of blood pigment (hæmoglobin, hæmatin, hæmochromogen, hæmatoidin).

5. In the progress of the differential diagnosis the blood serum should be studied both groosly and with the aid of the spectroscope.

NOTE.—Since this article was sent to the publisher the author has had another case of tubal pregnancy with intraperitoneal hæmorrhage. In this case the differential diagnosis between ectopic gestation and a threatened miscarriage (uterine gestation) was rendered especially difficult because of the marked retroversion of the uterus which existed. Macroscopic examination of the blood serum showed it to have a dark golden-brown color and the presence of blood-derived pigments was readily demonstrated by the Gmelin test. The Gmelin test applied to the urine also gave a strongly positive reaction for "bile." Consequently, on the basis of these observations an early and absolute diagnosis was made possible, even before the development of any icterus. At the operation a liter of fluid and clotted blood was found in the peritoneal cavity and a rupture of the left tube which contained a pregnancy.

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THE REPAIR OF CRANIAL DEFECTS BY AUTOGENOUS CRANIAL TRANSPLANTS[1]

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IN a series of 208 patients with head wounds under observation at U. S. General Hospital No. 11, 52 patients were operated upon for the repair of cranial defects. The study of this group of patients provides the data for estimating the influence of a skull defect as a factor in the disability of patients with head injuries, while the series of operations performed upon these patients supplied a satisfactory test of a method of cranioplasty which seems to possess decided advantages.

A considerable number of patients with war wounds of the head have a cranial defect which may be of slight importance in comparison with the associated brain lesions resulting in permanent hemiplegia hemianopsia, epilepsy, or cranial nerve palsies. The symptoms found in such patients with severe combined injuries of the skull, the brain, and its coverings may be modified to some extent by a cranial defect, and cranioplasty may give a certain amount of relief, but as a rule repair of a cranial defect does not benefit conditions resulting from structural brain damage. The repair of cranial defects should be performed with scrupulous regard for the limitations of cranioplasty which accomplishes two main purposes—protection of the brain and relief of deformity.

Healed projectile wounds of the skull present a rather characteristic appearance. An area of the scalp as well as bone has usually been lost, and often a long continued infection has added to the extent and density of the resulting scar. As a rule, the bony opening is irregularly quadrangular, although triangular, circular, and narrow linear defects caused by tangential wounds are seen.

In defects of moderate size without intracranial tension when the patient's head is higher than the body, the defect recedes, sometimes to considerable depth. It becomes level with the surrounding scalp, or protrudes when the patient lies down or stoops. It is this fluctuation of the defect which seems to be mainly responsible for the symptoms which are very characteristic. The patient complains of throbbing and pulsation about the defect, vertigo upon exertion, a feeling of insecurity, and particularly of the dread of injury to the unprotected brain. Any sudden change of position, such as stooping over, a sudden movement of the head, or coughing, may be followed by one or more of the symptoms. These patients are disinclined to physical exercise, and often suffer from disturbed sleep because of the throbbing or vertigo when lying down in bed. The symptoms may be

Fig. 1.

Fig. 2.

Fig. 3.

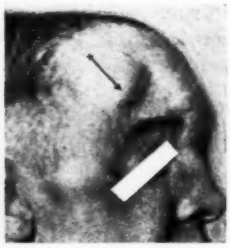


Fig. 4.

Fig. 1. Common type of cranial defect. The photograph shows the marked depression present when the patient is in the erect position.

Fig. 2. Craniofacial defect with marked deformity.

Fig. 3. Craniofacial defect destroying supra-orbital ridge.

Fig. 4. Defect of supra-orbital region; loss of bone in floor of orbit. Muscle control of eye lost, but vision preserved.

[1]Read at a meeting held by the Staff of U. S. General Hospital No. 11 for the Clinical Society of Surgery, June 14, 1919, Cape May, N. J.

Fig. 5.

Fig. 5. Cranial defect in right parieto-occipital region. The paper model lying on the scalp is exact size and shape of the defect. Photograph shows healing two weeks after repair of defect. There is no depression. (Operation by Charles H. Frazier.)

Fig. 6.

Fig. 6. Cranial defect and depression in left temporo-parietal region.

Fig. 7.

Fig. 7. Photograph of same case as that shown in Figure 6 taken two weeks after operation for the repair of the defect.

explained by the local instability of the brain mass, the traction of the adhesions, and the associated vascular fluctuations.

Craniofacial defects are often very conspicuous deformities, and require operation not only for its protective value but also for the cosmetic effect.

There are certain well known contraindications to cranioplasty. The operation should not be done for war injuries until the wound has been healed at least three months. Any associated intracranial process accompanied by an increase in tension, intracerebral foreign bodies, and sometimes epilepsy, makes the operation inadvisable.

The technique of cranioplasty has offered an attractive field for surgical ingenuity. Many materials have been used to replace the lost bone. Metal, rubber, and celluloid plates, homotransplants, animal transplants, and autogenous grafts from skull, tibia, scapula, and ribs have been recommended and to a large extent abandoned. While the tendency in all bone transplantation at the present time is to use autogenous grafts in reconstructive surgery whenever such material is available, there are some objections to the use of transplants from the tibia or ribs for the repair of cranial defects. The shape of the defect frequently makes it impossible to close accurately the skull opening with linear strips

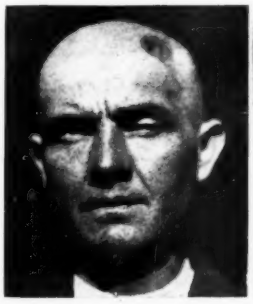


Fig. 8 (at left). Cranial defect resulting from the kick of a horse. Photograph 4 months after injury. Involvement of left third nerve with aphasia for one month after accident.

Fig. 9. Photograph of same case as that shown in Figure 8 patient two weeks after repair of defect.

Fig. 10. Plaster models of cranial defects.

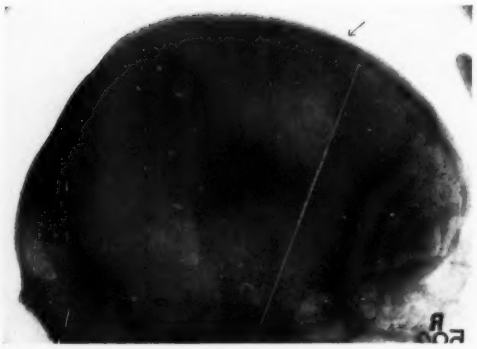


Fig. 11. Roentgenogram of parietal defect before operation.

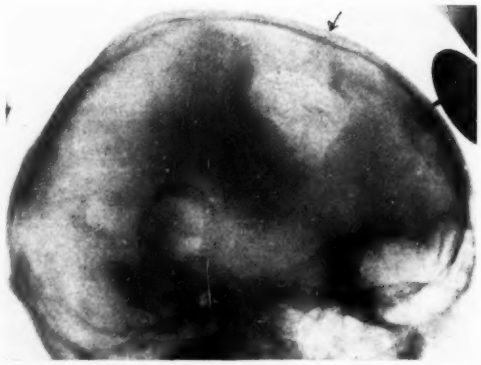


Fig. 12. Same as Figure 11 one month after repair of defect. Note characteristic appearance of graft.

although several may be used. The molding of these transplants to conform to the curve of the skull is often very difficult and it is not unusual to find marked depression over such transplants after firm healing. A minor objection to the rib or tibia transplant is the necessity of preparing two operative fields.

In the series of cases forming the basis of this paper, the autogenous cranial transplant has been used after the method of Charles H. Frazier, who has employed it in civil practice for a number of years with satisfactory results. This method requires practically the same preparation of the defect as is necessary when the transplant is taken from the tibia or ribs.

The scar tissue of the scalp is removed by an incision which follows the lines of the old scar. The dura is freed from the bony rim, which is beveled with a fine chisel. Foreign bodies and spicules of bone, if accessible, are removed, but the dura is not deliberately opened. A pattern of the defect is made with rubber dam or muslin and placed on the pericranium of the parietal eminence of the same side or of the contralateral side when the defect is large. The pattern is outlined on the bone with a small chisel and a thin lamina of the outer table removed with overlying pericranium. The transplant usually curls up during removal and resembles a thick fish scale mosaic

Fig. 13. Roentgenogram showing a large irregular defect in the right parietal region.

Fig. 14. Quadrilateral defect. First bone graft absorbed following pneumonia three weeks after operation. Reoperation (J. E. J. King) entirely successful.

with the fragments held in contact by the pericranial covering. The graft is molded into the desired curve by pressure, and placed upon the defect with its bony surface in contact with the dura. Fine interrupted catgut sutures fix the transplant in position by uniting the pericranium around the bony rim with that of the graft. The wound is closed in layers with free rubber tissue drainage over the defect and the area from which the graft is taken. The patient is usually kept flat in bed about two weeks. During this time the protrusion of the intracranial contents which the horizontal position favors will give the thin transplant the proper curve and allow it to set on a plane with the surrounding skull. This apparently slight addition to the postoperative management of recent cases has undoubtedly contributed to a better cosmetic result. It is not necessary that the graft be thick. Studies of bone regeneration seem to show that osteogenetic activity resides in the periosteum and the superficial layer of the underlying bone. The autogenous cranial transplants show satisfactory bone proliferation and give a firm protection without depression or ingrowing spicules. Cranial bones heal without much callus production, a fact which gives advantages to the cranial transplants over those removed from long bones. In many cases it is very difficult to discover, without X-ray examination, the location of a defect a month or six weeks after the operation.

In some patients, with extensive scars overlying the defect, it is impossible to close the scalp without undesirable tension. It seems better in such cases to do first a plastic operation upon the scalp and cover the defect with healthy skin, reserving the cranioplasty for a later operation. Tension of the scalp not only interferes with wound healing in these cases but also tends to flatten and depress the transplant, thus preventing a good cosmetic result although the defect may be firmly protected. Ether anæsthesia was used in all cases.

The improvement in patients who have had defects repaired by the method described is very striking. The aversion to physical exertion generally disappears, the discomfort arising from pulsation, throbbing, and dizziness in sudden movements is relieved or improved, and the patient undertakes with great optimism the physical re-education so frequently of benefit in the treatment of old head injuries.

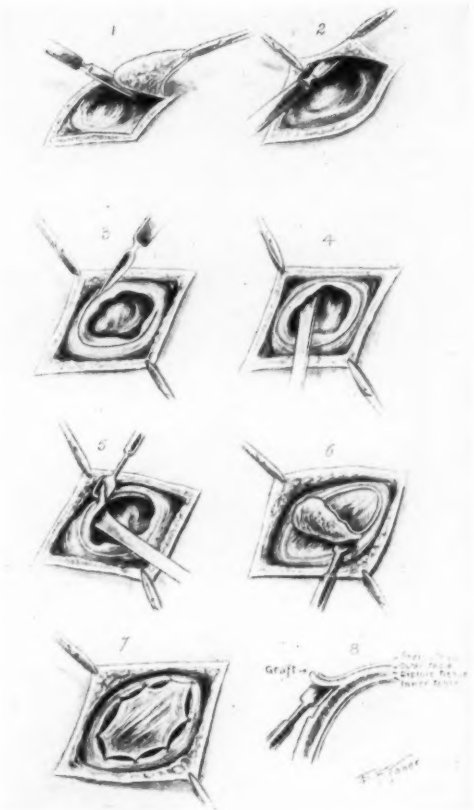


Fig. 15. Consecutive stages of operation.

1. Excision of scar from defect.

2. Exposure of rim of defect by incision through scar.

3 Incision through pericranium about a quarter of an inch from the edge of the defect. The purpose of the incision is to provide for bone contact with the graft and to free the adherent dura.

4. The pericranium within the incision, *3*, is forcibly displaced within the defect by an elevator. Adhesions of the dura to the edge of the bone are thus freed.

5. Beveling the edge of the defect for contact with the graft. The dura is carefully protected by a thin spatula.

6. Removal of the transplant from the parietal eminence. The size and shape of the transplant has been modeled by rubber dam and the graft cut to fit accurately.

7. Shows graft partly sutured by uniting the pericranium of the graft with that surrounding the defect.

8. Cross section of graft.

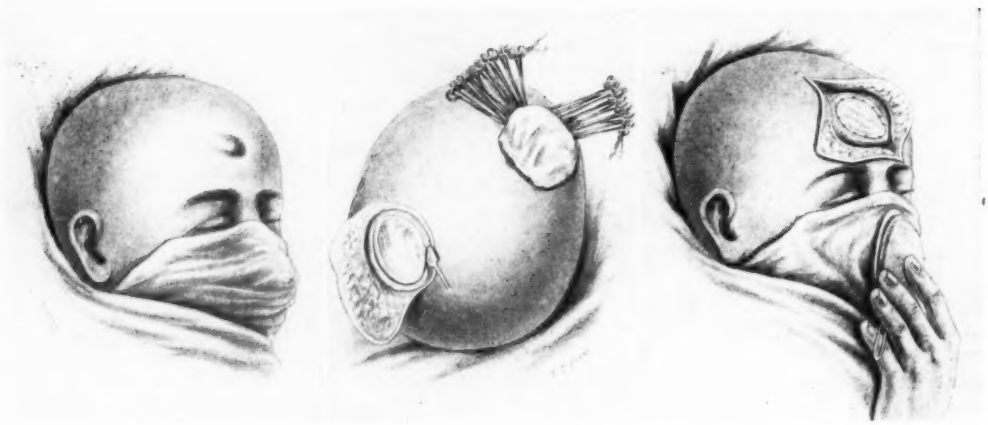


Fig. 16. Fig. 17. Fig. 18.

Fig. 16. Sketch of craniofacial defect.
Fig. 17. The defect has been prepared for transplantation. The graft is outlined on the left parietal eminence.
Fig. 18. Completed suture of the graft. The incision in the scalp is usually united with a double row of sutures.

In the series of cases which form the basis of this discussion, all the patients recovered from the operation. In one patient the graft was entirely absorbed following a severe pneumonia with empyema which developed independently of wound healing three weeks after operation. Partial absorption of the graft took place in one case in which the transplant was immersed in alcohol, and in which there was some necrosis of the skin flap.

Postoperative X-ray studies have shown no ingrowing spicules of the graft and no excessive proliferation of the inner surface of the graft.

In properly selected cases, cranioplasty is a safe operation of proved value. The experience accumulated in the repair of defects caused by war wounds will doubtless find a helpful application in the head injuries of industrial life.

SUCCESSFUL EXPERIMENTAL HOMOTRANSPLANTATION OF THE KIDNEY AND THE OVARY[1]

By CARLETON DEDERER, A.B., M.D., M.S., Bay City, Michigan
Department of Surgery, Jones Clinic

THE dream of surgery will have been realized when it has become possible to transplant a vital organ from one individual to another. By the term "transplant" we mean the removing of an organ entirely and the placing of it in a new position, uniting its major blood-vessels with others for the purpose of establishing adequate blood supply to the organ. The term "graft" in this connection refers more particularly to the placing of disconnected pieces of tissue in viable contact with other tissues but without any blood-vessel anastomosis.

Dreams, however, are only for dreamers. As far as the practical application of organ transplantation has progressed, the "hem of the garment" has yet to be touched.

Prior to the completion of this work, the literature showed a few unsuccessful attempts to obtain functional homotransplantation of a kidney in the dog and perhaps one or two unsuccessful attempts to obtain homotransplantation of the ovary.

The left kidney and ovary together with their blood supply were transplanted from one puppy to the neck of another of the same litter. Circulation through the organs was continuous with the exception of 42 minutes during which time the organs were simply left out in the air in the field of operation.

An avoidable accident, which almost cost the life of the dog, occurred during this operation. The venous anastomosis was completed first. The temporary clamp on the vein had become removed in some way. This was observed but it was thought that no harm would result. However, during the arterial anastomosis the vein had become filled with blood which had clotted. In order to save the experiment the clot which was about 2 or 3 centimeters long was pushed along into the general circulation. In a few minutes the dog showed signs of respiratory paralysis. Artificial respiration appeared to be unavailing. The sterile towels were being removed when as a result of persisting in artificial respiration the dog breathed. The breathing returned to normal after about 10 minutes of Cheyne-Stokes respiration. Operative conditions were again restored by painting the kidney and wound with 4 per cent iodine in ether and by flushing the wound with Dakin solution. On the evening of the same day, urine flowed from the ureteral orifice and continued to flow in waves as long as the dog lived, in spite of the fact that some of the urine was excreted by its own two kidneys. The function of this kidney was demonstrated from time to time including one test on the twenty sixth day after operation. On this day phenolsulphonephthalein was freely excreted; it appeared in 2 minutes and 40 seconds after its intravenous administration.

Fig. 1. Dog D21. Gross specimen of the transplanted kidney and ovary. Fixed in formalin.

[1] Extract from thesis accepted by the Graduate Faculty of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, June 19, 1919.

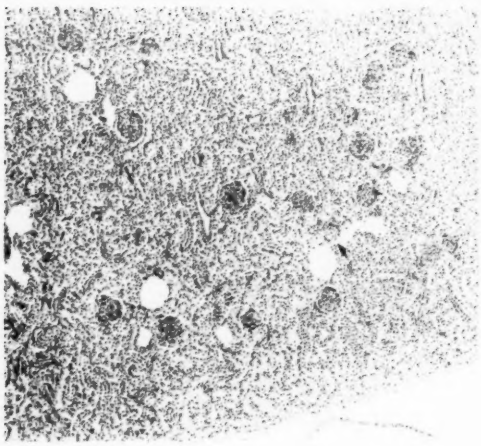


Fig. 2. Dog D21. The dog's own left kidney. Fixed frozen section. Hæmatoxylin and eosin, X50.

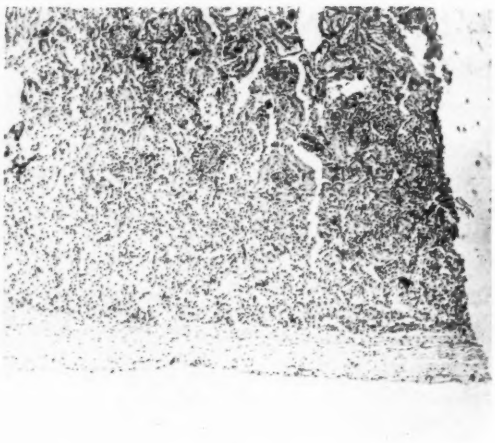


Fig. 3. Dog D21. Homotransplanted kidney on 27th day. Fixed frozen section. Hæmatoxylin and eosin, X50.

On the eighth day, the dog became affected with that virulent disease, distemper, which clinically resembles epidemic influenza. The disease became progressively worse, and though periodically improved by persistent treatment, eventually the dog was lost.

On the evening of the twenty-sixth day the dog was examined as usual. There was less nasal discharge. The brightness of the dog's appearance suggested an abatement of the respiratory infection. However, as the dog did not walk around and only stood still, further examination was made. The symptoms and signs observed led to the diagnosis of intussusception.

The dog was etherized and placed on the operating table about 10 P.M. Intussusception of the lower small intestine was found and reduced in time to prevent any vascular disturbance. An acute inflammatory lesion, comprising œdema of the intestinal wall and ulceration of the mucous membrane, was found at the entering end of the intussuscipiens. The affected area was excised and closed by suture. The wound was closed. The dog died the next day.

Necropsy showed the signs of distemper, particularly a generalized bronchopneumonia. Healing at the site of intestinal repair had hardly begun. The transplanted organs were removed under operative conditions and were tested as to transplantability by anastomosing the renal vessels to the splenic vessels of another dog. Arterial union was satisfactorily made but the venous anastomosis was not accomplished, in a measure, because of the development of dense adventitia. The arterial blood which entered the kidney was under considerable pressure because only a portion of it escaped at the site of attempted venous anastomosis. However, no damage was observed to result from this influx of blood as was shown by microscopic examination of fixed and frozen sections. The organs were then detached and placed in 10 per cent formalin for further examination.

EXTRACT FROM THE PROTOCAL

Dog 21 was operated upon February 13, 1919, under ether anæsthesia. At 10:13 a. m., the incision was made. At 10:48 a. m., the renal artery was clamped in donor. At 11:30 a. m. the circulation was re-established.

The organs were out of circulation 42 minutes. At 12:02 p.m., the wound was closed.

February 13. Clear excretion appeared from the transplanted kidney.

February 14. The urine was yellowish and clear, with an occasional squamous cell present.

February 15. Clear urine flowed in waves.

February 16. The spurt of urine extended about 2 millimeters from the skin surface.

February 17. Waves of urine came 7 to the minute. Some of the stitches were cut.

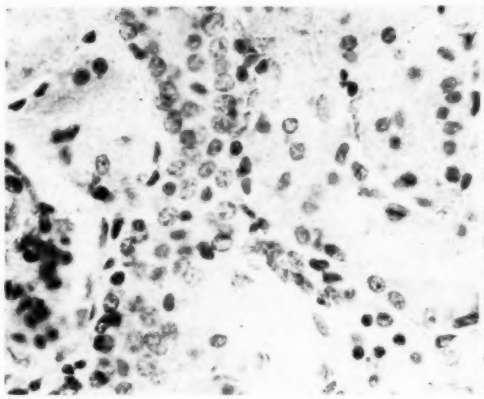


Fig. 4. D21. The dog's own left kidney. Fixed specimen frozen sections. Hæmatoxylin and eosin, X500.

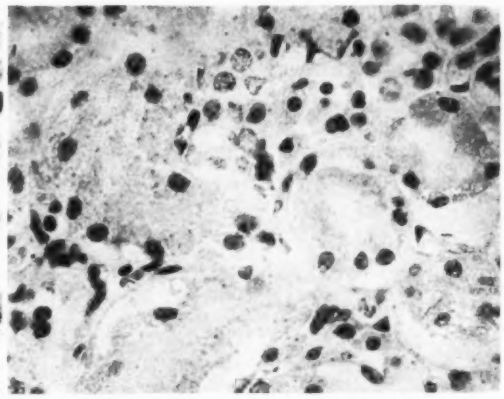


Fig. 5. The transplanted kidney.

February 18. The urine flowed in waves. The ureter was flush with the skin.

February 19. Epithelial cells were found in the urine which was clear.

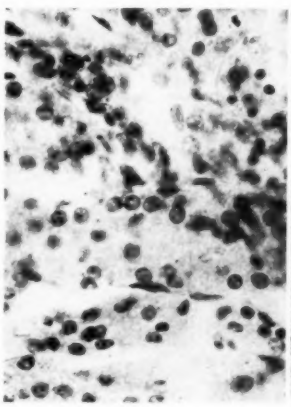
February 20. The urine was clear and flowed in waves. Solitary epithelial cells and a few leucocytes were present.

February 21. The urine flowed 10 drops to the minute. Leucocytes were again present appearing 15 diameters apart in a drop; epithelial cells were also present. There was no albumin. There was a purulent nasal discharge and a cough.

February 22. Dermatitis developed from the excretion of urine. Triple phosphates and leucocytes.

February 23. The urine flowed 2 to 5 waves to the minute. There were thirty leucocytes to a high power field under a cover glass. Gentian violet allowed to run under the cover glass stained an organism which was fusiform, encapsulated and in chains of 2 to 5.

February 24. Erythrocytes 50 to a high power field. The caretaker reported later that the dog was out of its cage in the morning which meant that the dog had fallen three or four times its height. Smear



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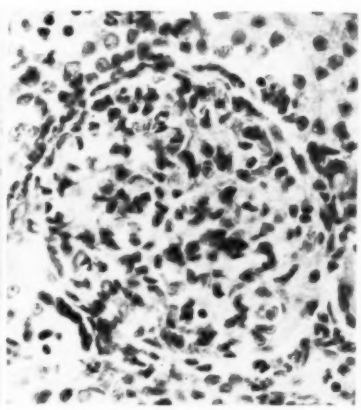

Fig. 8.

Fig. 6. Dog D21. Transplanted kidney. Fixed frozen section. Hæmatoxylin and eosin, X500.

Fig. 7. Dog D21. Transplanted kidney showing a portion of the kidney which was congested without extravasation. Fixed specimen, frozen section, hæmatoxylin and eosin, X50.

Fig. 8. Dog D21. Transplanted kidney. Congested glomerulus without extravasation. Fixed specimen, frozen section, hæmatoxylin and eosin, X500.

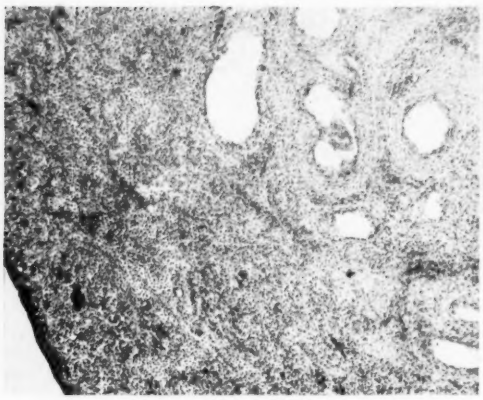

Fig. 9. Dog D21. The dog's own left ovary. Fixed frozen section. Hæmatoxylin and eosin, X50.

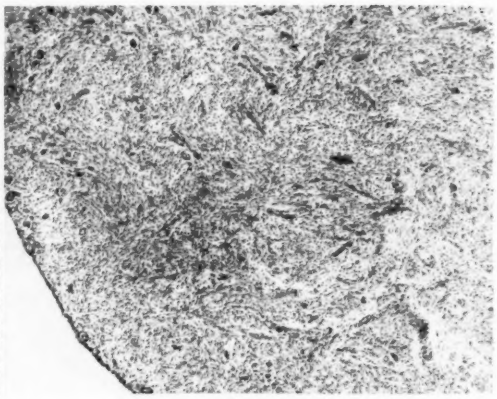

Fig. 10. Dog D21. Transplanted ovary. Fixed frozen section. Hæmatoxylin and eosin, X50.

from the nose and the ureteral orifice in the skin showed gram positive diplococci occurring in pairs, fours and singly. At 9:00 p.m. urine coming in waves and clear.

February 25. Six waves of urine were seen in 1 minute and three in the next. Phenosulphonephthalein was strongly excreted in 2 minutes and 50 seconds after intravenous injection of about 1 cubic centimeter.

February 26. The dog had a nasal discharge and a troublesome cough. Microscopic examination of the urine from the transplanted kidney showed an occasional leucocyte and erythrocyte. Culture from the nasal discharge showed the presence of gram negative chain bacilli, gram positive bacilli occurring end-to-end in pairs.

February 27. There was a little blood in the stools, diarrhœa, temperature 39.6°. The urine from the transplanted kidney was clear, acid, and free from albumin. Microscopic examination showed an occasional leucocyte. The bladder urine was clear, acid, and microscopically contained several clusters of leucocytes. Vapor treatment for distemper was given several times daily often for over an hour, as the dog slept.

February 28. Urine clear.

March 1. The dog was languid and had anorexia; the urine flowed as usual in waves.

March 2. The neck was somewhat inflamed from the urine, which was clear. The dog ate again.

March 3. The urine was clear. Twenty-five waves counted in 5 minutes. Weight, 2.7 kilograms.

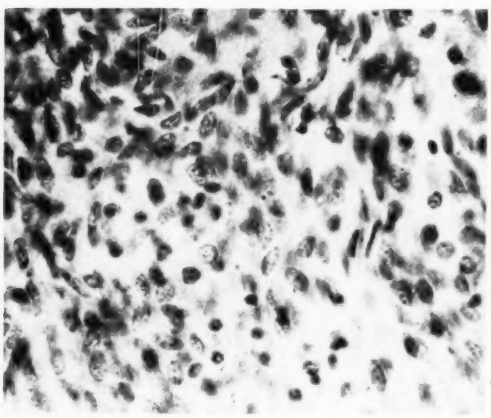

Fig. 11. Dog D21. The dog's own left ovary. Fixed frozen section. Hæmatoxylin and eosin, X500.

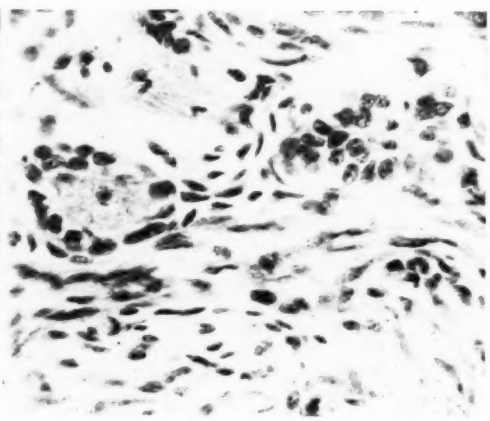

Fig. 12. Dog D21. Transplanted ovary. Fixed frozen section. Hæmatoxylin and eosin. X500.

March 4. The urine came in good sized waves.

March 5. Microscopic examination of the urine from the transplanted kidney showed an occasional leucocyte (no casts, crystals, epithelial cells, or cellular detritis).

March 6. Dermatitis of neck appeared.

March 7. The dog suffered from anorexia and paroxysms of coughing.

March 8. Bloody diarrhœa. Food that was given by inducing the dog to swallow was vomited.

March 9. Weight 2.4 kilograms. There was a profuse purulent nasal discharge. The dog licked its fur and wagged its tail but still was very weak.

March 10. The urine flowed in good sized waves. In the afternoon about 1.5 cubic centimeters of phenolsulphonephthalein was given intravenously. It appeared at the ureteral orifice on the skin in 2 minutes and 40 seconds. A photograph was taken about an hour after the phenolsulphonephthalein was given. The renal artery could be felt pulsating. At 9:00 p.m., intussusception was diagnosed. The dog was operated on, the intussusception was reduced, and an ulcerated area repaired.

March 11. The dog died.

Necropsy. The dog was emaciated. The trachea contained purulent material. The right ventricle of the heart contained a well organized thrombus. An organized thrombus in the left ventricle had some recently clotted blood attached to it. There was no evidence that the thrombi were of pathological importance at this time. There was a generalized bronchopneumonia. The œsophagus was negative. The stomach was negative, containing a little fluid. the repair in the small intestine had hardly agglutinated sufficiently to make it fluid-tight. The liver, gall-bladder, pancreas, kidneys, ovaries, and bladder were negative except that both kidneys were stained with phenolsulphonephthalein.

The transplanted kidney was normal in external appearance, somewhat adherent to the cervical tissues and in its proper location. There was an enlarged lymph node attached more particularly to the peritoneal ovarian ligament. The ovary was normal in appearance. The ovarian vessels were patent and in good condition. The renal artery was less than 1 millimeter in diameter. The artery and vein were in good condition. (Figs. 1 to 13).

Fig. 13. Dog D21. Distal end of ureter sectioned at its site of union with the skin. Fixed frozen section. Hæmatoxylin and eosin, X50.

CONCLUSIONS

1. A homotransplanted kidney during 26 days has passed the same functional tests as are required of normal kidneys.

2. In dogs of the same litter a homotransplanted kidney and ovary lived for 26 days. Pathologic examination showed that the organs reacted to the severe constitutional infection, distemper, in a manner similar to that in which the animal's own organs reacted.

3. Phenolsulphonephthalein after being injected into the external saphenous vein began to be excreted from a homotransplanted kidney in 2 minutes and 40 seconds.

4. It is possible in making a homotransplantation of the kidney to get a satisfactory arterial anastomosis by suture when the renal artery is less than 1 millimeter in diameter.

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IMPACTED FRACTURE OF THE NECK OF THE FEMUR

PATIENT WALKING FROM TIME OF ACCIDENT

BY HOWARD LILIENTHAL, M.D., F.A.C.S., NEW YORK CITY

THIS case is reported because it is probably the first one in which it has been actually proved that an impacted fracture of the neck of the femur is not necessarily followed by a period of inability to walk. I have heard of similar cases in which this condition had been suspected, but here we have one in which the evidence is beyond question.

Fig. 1. Case of Mrs. M. J. R. Roentgenogram made between 2 and 3 weeks after the accident. Diagnosis: Impacted fracture of the neck of femur.

Mrs. M. J. R., age 50, fell, on August 20, 1919, striking heavily upon the right trochanter. She was able to walk with assistance immediately after the accident but upon the advice of her physician, remained in bed 10 days. The accident occurred in a small town in New Jersey and as the X-ray apparatus of the hospital was out of order, no radiographic examination was made until 3 weeks after the injury. At the end of the 10 days, however, the patient walked about with assistance and later unaided. She was examined by several physicians who made the usual manipulations without causing excessive pain. There was some pain, however, both on motion and while lying down, the distribution of which was from the groin down to the right knee anteriorly.

Three weeks after the accident, X-ray examination disclosed an impacted fracture of the neck of

Fig. 2. Same case as Figure 1. Hips accidently included in a gastro-intestinal roentgenogram made 4 weeks before the accident. Note normal contour of parts. The hips were faint in this picture because they were not deliberately included. It was, therefore, necessary to outline them for this illustration.

the right femur, the neck apparently having been driven into the head with some tilting of the head. The right (injured) leg measured three-quarters of an inch more than the left, from the anterior superior spine to the tip of the inner malleolus, and there was the same discrepancy in measurements made from the umbilicus to the malleolus. The patient stated that she knew that her right lower extremity had always been longer than the left and she had been in the habit of wearing a lift in the left shoe. There was also some scoliosis.

Examinations by several physicians resulted in the unanimous opinion that there was no recent fracture but that the deformity was probably due to a severe fall which the patient had had at the age of 12. She had then been confined to bed for about a week and had had leeches applied to the region of the right hip where there was a large discoloration.

My first examination of the patient was on October 22, 1919, and although from the history it was almost incredible that there had been a recent fracture of the femur, I could not deny the possibility of this diagnosis on the evidence of the X-ray. There appeared to be no way to clear up the mystery until the patient herself recollected that a few weeks before the accident of August 20, 1919, Dr. Imboden had made a radiographic study of her gastro-intestinal tract probably taking in the hips. These pictures compared with the recent ones made by the same radiographer (following the fracture) should set the matter at rest, and indeed, the gastro-intestinal plate clearly showed both hips to be normal.

CONGENITAL ABSENCE OF THE VAGINA AND UTERUS

A Consideration of This Problem In the Light of the More Recent Endocrine Studies and Surgical Advances, with the Report of a Case Successfully Operated Upon by the Baldwin Method, Slightly Modified

By M. R. ROBINSON, M.D., F.A.C.S., New York City
Adjunct Gynecologist, Beth Israel Hospital; Gynecologist, Sydenham Hospital

THE congenital absence of the uterus and the vagina is not only of academic interest, but also of great clinical importance. The earliest case on record is credited by Burrage (1) to Realdus Columbus, who has described this anomaly in 1752. Since then many similar observations have been published. Neugebauer (2) in 1895 had collected 1,000 cases. It would hence be trite to chronicle additional reports of this anatomical defect, on account of its rarity alone. Recent surgical and medical advances have widened the horizon of this problem considerably. Today, we are not only able to correct these structural defects to a degree bordering closely on the normal (I mean the vaginal defect), but what is of equally great, if not greater importance, is the clinical precision with which we select our cases for operative therapy.

The etiology of congenital maldevelopments is still shrouded in obscurity. We are as yet unable to offer any rational explanation as to the "why" and the "wherefore," which causes the disturbance in the potential cells of the embryo, with its consequent disfigurements. Embryology merely helps us better to understand wherein the developmental error differs from the normal, so that we may undertake the corrective measures with a clearer conception, but it leaves us equally in the dark as to the primary cause of the genetic failure.

The malformation claiming our attention for the present, relates to the vagina and the uterus. In the adult, the various subdivisions of the generative tract appear as separate and distinct anatomical entities. In their embryological state, however, they form one continuous tube, which communicates with the urinary apparatus in front, and with the terminal bowel posteriorly (Fig. 1). As development progresses, the originally uniform tube begins to undergo variations in shape and size. The skin depression, the epiblast, becomes deeper and deeper, in order to meet the rectum to form the cloaca (Fig 2). The cloaca then divides into an anterior part, the urogenital sinus, into which the muellerian ducts open, and a posterior part, the

Fig. 1.

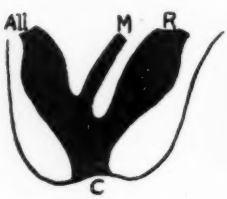
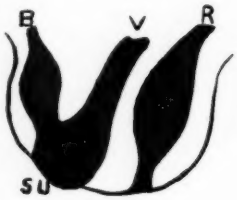


Fig. 2.



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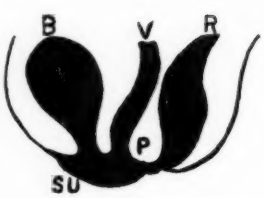

Fig. 4.

Fig. 1. *all.* Allantois; *m*, muellerian duct; *r*, rectum; *d*, depression of skin growing upward to form vulva.

Fig. 2. *c*, Cloaca formed by the union of the skin depression with the rectum and the allantois.

Fig. 3. *b*, Bladder; *v*, vagina; *s.u.*, sinus urogenitalis; *r*, rectum; *p*, perineum.

Fig. 4.

anus. This division is brought about by a growth of tissue downward, between the hind gut and the allantois, and the perineum is thus formed (Fig 3). About this time the vagina is beginning to be more distinct. The uro-genital sinus contracts at its upper part to form the urethra, while the lower part remains as the vestibule into which the vagina also opens.

The formation of the uterus depends upon the proper and timely fusion of the muellerian ducts. Each of them begins near the cranial extremity of the wolffian body, where several irregular masses of cylindrical epithelium, derived from the peritoneal epithelium, coalesce and form the ostium abdominale tubæ. From the center of this depression, the true tube anlage begins to grow. At first the fallopian tube is a solid strand of tissue, but later on it becomes tubular. In the process of its descent into the pelvis, the muellerian duct lies at first to the outer side of the wolffian duct, then it crosses it ventrally, to assume later on an inner or median position. Beyond this crossing, it meets its prototype of the other side with which it unites and forms the genital cord, from which the uterus and the vagina develop (Fig. 5).

This brief embryological review will assist us materially in understanding the anomaly which forms the basis of this report.

DIAGNOSIS

It is hardly necessary, as some clinicians claim, to resort to the use of anæsthesia, in order to establish a diagnosis of absence of the uterus, or the vagina, or of both. It seems to me that a careful anamnesis will, in most instances, suffice. For clinical purposes it would be expedient to subdivide these cases into three distinct classes, although such a subdivision must be considered as arbitrary, for some of these groups merge one into another.

a. Absence of the uterus. Patients harboring this defect are free from any physical pain or discomfort; they are only conscious of the fact that they do not menstruate. Should they espouse matrimony, they may even enjoy conjugal bliss, and it is only, when after months or years of marital life, the expected progeny is not forthcoming, that they begin to inquire as to the cause of their sterility.

b. Absence of the vagina. Soon after puberty has been established, these individuals begin to suffer from periodic attacks of pain in the lower abdomen. As time progresses their sufferings increase in severity, due to the accumulations of retained menstrual secretions. At times a palpable tumor may make its appearance in the hypogastric area, constituting a hæmatometra. These patients naturally come under our notice at an early period in their sexual life.

c. Absence of the uterus and vagina. This last class, will like the first one enjoy freedom from physical discomfort. If they remain celibates, their single blessedness will continue unperturbed, and they may escape our observation altogether. On the other hand, should they enter upon connubial life, then the expectant happiness, consequent upon the gratification of the ardor sexualis, will soon be turned into abject grief and disappointment, for a bar to coitus is encountered by the male partner. The patients coming

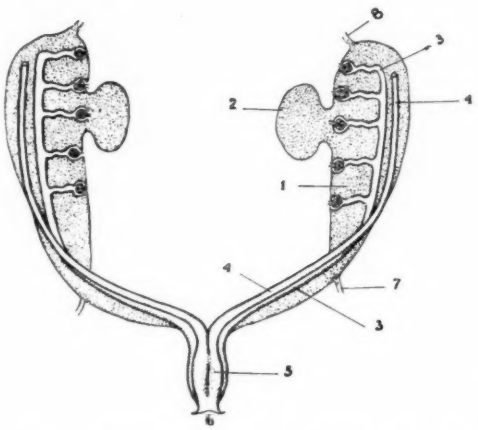

Fig. 5. Schematic drawing of the internal genitalia in a human female embryo, 3 to 4 centimeters in length. *1*, wolffian body; *2*, germinal gland (ovary); *3*, wolffian duct; *4*, muellerian duct; *5*, genital cord; *6*, lower end of the muellerian duct in the urogenital canal; *7*, anlage of round ligament; *8*, diaphragmatic ligament of the primordial kidney.

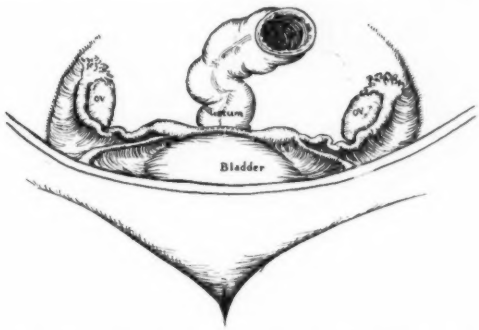

Fig. 6. Drawing showing findings in author's case. The dotted line indicates the location of the first incision.

under this last named category will be the ones who will tax our surgical and clinical ingenuity to its utmost, for we have to know not only how best to repair their defect, but also when the indication for such an operation is justifiable.

INDICATIONS FOR OPERATION

The mere fact that an individual has from its very birth been classified as a female, basing this classification upon the anatomical configuration of the external genitalia only, and this sexual differentiation has been further accentuated by the maintenance of an environment conforming to this classification, does not in the least prove that such a determination of the sex has been correct. It may sound quite paradoxical, but it is scientifically true nevertheless, that many individuals with a vagina and uterus, and who even menstruate at stated or irregular intervals, are not women in the full sense of the word; and that many persons with testicles, are really feminine in every other respect. Who that is abreast of the times in the study of the sex complex would be satisfied with so meager a classification of sex? If, with the exception of the female genitalia, an individual has a deep heavy voice, large hands and feet which are covered with a marked hirsuties, whose upper lip is adorned with a juvenile mustache, whose mammary glands are small and poor in adipose tissue, whose thorax is wide and hips narrow, whose pubic hair line extends in the median line up to the umbilicus, and who has chosen as her vocation and avocation occupations and interests suited for a male; are we justified in the face of all these objective and subjective signs to designate such an individual as a female? Conversely, can we scientifically term an individual possessed of male genitals, man, who is beardless, whose voice is thin, whose skin is smooth and fair, whose pubic hair line is horizontal, whose hips are broad and chest narrow, and who is shy and reticent, and lacks the aggressiveness and boldness so characteristic of sturdy manhood?

To the clinician versed in endocrinology these physical and psychic phenomena spell distinct disturbances in the correlation between the gonads and the rest of the endocrine glands. In the female of the type described above, he at once recognizes an oversupply of adrenal secretion, an hyperfunction of the pituitary (anterior lobe), with a concomittant hypofunction of the thyroid and ovaries. In the male, the adrenals seem to have lagged behind, the pituitary has not developed sufficiently, or the posterior lobe has perhaps gained in ascendency over the anterior, there might also have been a persistence, or late involution, of the thymus and the pineal.

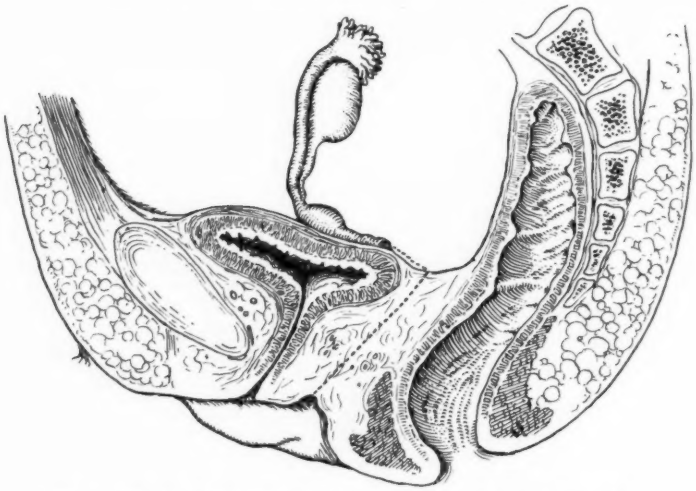

Fig. 7. The dotted line illustrates the course of dissection and separation.

In view of the facts thus adduced, it becomes apparent that the postpubertal determination of sex is no longer as simple a matter as we were wont to believe. We see that any disturbance in the harmonious play between the endocrine glands leaves its imprints not only upon the physique but also upon the psyche of the individual. Hence "femininity" and "masculinity" depend upon the proper and harmonious relation and correlation of all the internal secretions.

When the gynecologist, therefore, is confronted with the problem of absent vagina and uterus, and both interested parties are willing to have the existing defect corrected, it becomes his supreme duty to assure himself, objectively and subjectively, before he decides to operate, that the subject selected is a female, endowed with all the attributes pertaining to her sex. For sad indeed would be the result, in spite of a mechanical or anatomical operative success, if the newly constructed vagina was created in a masculine female.

This last statement needs perhaps some elucidation. It is generally accepted that the sublime goal of matrimonial union is offspring. But we cannot deny the fact that the basic principle upon which love is primarily founded, is sexual desire. The gratification of this elemental passion in its broader sense requires something more than a mere copulating channel; it also requires sexual affinity, and unless the individual upon whom the operation is undertaken is a female, in the wider conception of the term, she will not be able to contribute this most important element to matrimonial happiness, no matter how closely her newly constructed vagina, may simulate the normal.

CHOICE OF OPERATIVE PROCEDURE

In 1906, A. Brothers (3) in a monograph entitled, "A Construction of a New Vagina," has most ably reviewed all the operative procedures known up to that time. An analytical survey reveals the fact that for a long time most of the operations undertaken resulted in failures. For most of the surgeons have expected that the newly formed channel, burrowed in the soft tissues between the bladder and the rectum would retain its patency after prolonged packing. They have completely lost sight of the facts and laws governing the repair of tissues, that raw surfaces will adhere to each other, through the growth of granulation tissue, the moment the intervening foreign substance is removed. The later school of surgeons have realized this mistake, and as a result, pediculated skin flaps, taken from the immediate vicinity,

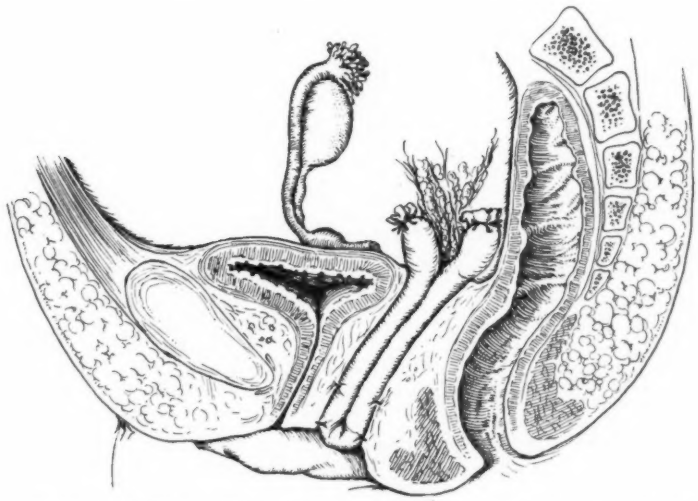

Fig. 8. A double loop of intestine has been drawn down into the tract which has been previously established.

or Thiersch grafts taken from more remote parts of the body surface, began to be employed, as a lining for the newly formed tunnel. It can readily be seen that this new attempt was as yet far from the ideal, for while it maintained patency, in some of the successful cases, it lacked the softness, the smoothness, and the lubrication of the normal vagina. In fact some of the results were worse than useless, for not only were some of these newly constructed vaginæ lined with a dry horny epithelium, but at times, even with a surface growing hair. This of course was due to the carelessness of the surgeon in selecting the region from which the grafts were taken. It was not until 1904 that Baldwin (4) first suggested the employment of an excluded loop of intestine as a lining for the new vagina, and thus created a copulating channel that would correspond as closely as possible to a normal vagina. In 1910 the same author (5) reported 6 cases upon whom he carried out this operation most successfully.

CASE REPORT

A. B., age 24, married 9 months, consulted me on May 11, 1919, complaining of difficulty to participate in the sexual act, as her husband finds an obstruction, preventing intromission. She volunteered the information that she experienced libidio sexualis, and is very anxious to be able to satisfy her husband sexually.

Clinical history. She has never menstruated, but since her seventeenth year is subject to periodic attacks of discomfort, characterized by the following disturbances: dull headaches, enlargement of the mammary glands, swelling of either one or the other lower extremity, and mild hæmoptysis. These disturbances would last for about 4 days, then they would subside, accompanied at times by a peeling of the toes.

Physical examination. The patient is of medium height, and correspondingly normal weight. Her body outline was feminine, the skin fair and smooth, the mammary glands well developed, the hairy distribution normal. The external genitalia, including the mons, the clitoris, and the labia majora and minora were normal. The vaginal canal was represented by a blind sack, located at the normal site, measuring about half an inch in depth. Recto-abdominal palpation failed to reveal the presence of either a cervix or a uterus, nor could the uterine adnexa be felt.

The objective and the subjective signs and symptoms presented by this patient were distinct enough to make a positive diagnosis that this woman was feminine in every respect, and was therefore a fit subject for operative measures which will correct her anatomical defect.

Operative findings and procedure. Instead of beginning my operation as has been advocated by Baldwin, with the perineal dissection first, working blindly between the bladder and rectum until the peritoneum is reached, and then opening the peritoneal cavity from above, I proceeded from the very

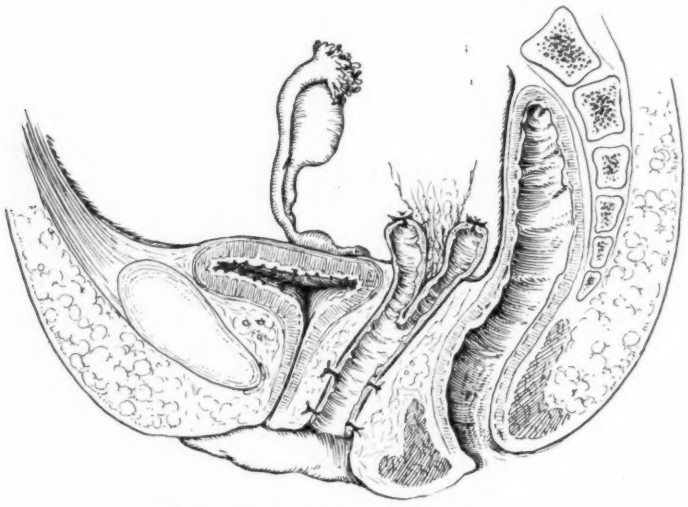

Fig. 9. Result of operation in author's patient

start by the abdominal route, as it seemed to me to be a much safer way. On opening the peritoneal cavity with the patient in a Trendelenburg position, the pelvic cavity presented the following anatomical picture (Fig. 6): To either side of the median line there was a fully developed fallopian tube with a corresponding ovary and round ligament. The uterine end of each tube terminated in an enlargement corresponding in shape and size to that of an olive pit, which has joined by its inner end a similar structure of the opposite side, thus forming a round band lying at the upper border of the septum which separated the bladder from the rectum. These olivary bodies are most likely rudimentary uteri. The dotted line in Figure 6 indicates the point where I made the first incision and then proceeded to separate the septum between the bladder and rectum down to the floor of the pelvis. An assistant in the mean time had pushed from below with a dull instrument, against the roof of the vaginal pouch, thus putting it on a stretch and bringing it in closer apposition with the floor of the pelvis, which was now incised. This step established a communication between the vaginal skin depression and the peritoneal cavity. The dotted line in Figure 7, illustrates quite clearly the course of my dissection and separation which was accomplished with comparative ease, and with more assurance than is experienced when the operation is started from below. For in this procedure, the bladder and the rectum are all the time under our direct supervision, and we do not have to rely solely upon our sense of touch. Having established the vaginal canal, it was temporarily packed with gauze, and the third step in the operation was begun. This consisted in isolating a loop of ileum of about 12 inches in length, at a point 10 inches from the ileocæcal junction. The free ends of this loop were inverted, after having re-established the continuity of the intestinal tract. Pains were also taken not to impair the blood supply of the isolated loop. The closed end of the double loop of intestine, as shown in Figure 8, was drawn down into the previously established tract, by means of a piece of tape tied loosely to the bend of the loop, which was pulled from below, until it protruded for about 1 inch beyond the skin border. The parietal peritoneum at the center of the broad ligaments, or the vesicorectal septum, was now reunited around the proximal ends of the intestinal loop, thus isolating them from the general peritoneal cavity. The abdomen was now closed in the usual manner, and the proper dressing applied. The patient was next placed in the lithotomy position thus exposing the protuding intestine, which was secured in place with several chromic catgut sutures. The convex surface of the loop was incised, and rubber tubing about 8 inches in length was inserted into each arm of the loop. A T binder was applied to the perineal region and patient returned to bed, in good postoperative condition. The operation had lasted almost 2 hours.

Subsequent observations. The patient has made a most satisfactory convalescence, and was out of bed in 18 days. I have examined this patient since then about once every 6 weeks. The last examination was made on September 18, 1919. The condition found at that time may be described as follows: the vaginal canal admits 2 fingers readily to a depth of 4.5 inches; beyond this point, a constriction is encountered, which under slight pressure permits the index finger to pass beyond it. Above this narrowing the two separate intestinal

lumina are distinctly felt with the intervening spur (Figure 9). She also stated that intercourse is now possible and gratifying.

SUMMARY

1. The diagnosis of absent vagina and uterus, or of vagina alone, can in most cases be made from the clinical history, supplanting at times the physical examination, when the latter is not readily obtainable.

2. Operative measures tending to create a vaginal tract should be undertaken only in individuals who are physically and psychically women, in the full sense, which this definition implies.

3. In order that the newly constructed vagina should approach the normal as closely as possible it should be lined with a soft, lubricated mucosa, and the employment of an intestinal loop for that purpose, as advocated and executed by Baldwin, is the choice operation.

4. It is my personal belief that it is much safer to start the separation of the tissues interposed between the rectum and the bladder in order to establish the copulating channel, from above, instead of from below.

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THE ARTERY OF THE UTERINE ROUND LIGAMENT

By J. F. BALDWIN, M.D., F.A.C.S., Columbus, Ohio
Surgeon, Grant Hospital

IN describing the operation of abdominal hysterectomy, every modern surgical textbook with which I am familiar, directs that the round ligament be doubly clamped or ligated before cutting so as to control hæmorrhage from the artery which is supposed to run in that ligament and to form an important part of the blood supply of the uterus. This part of the technique is especially emphasized in the *Atlas of Operative Gynecology* just issued by Barton Cooke Hirst, of Philadelphia. In this he alludes several times to the "three arteries on each side" all of which must be carefully ligated.

A number of years ago, while in charge of the department of anatomy in a local medical college, I made a study of the blood supply of the uterus, and in later years, because of these reiterated directions as to the round ligament artery, made a second study of this circulation. As a result of these studies I found that there was no blood supply reaching the uterus through the round ligament, but that a minute artery which runs out in the ligament carries blood from the uterus into the ligament; this artery being so small that in the ordinary technique of hysterectomy the round ligament can be cut across with absolute impunity. This I have demonstrated thousands of times in the operating room, and have more than once incidentally called attention to it in medical journal articles. In brief, the blood supply to the round ligament is very scanty, and is purely for the nutrition of the ligament and not for distribution to points beyond.

After going through Hirst's *Atlas* it seemed to me that it was time to correct this anatomical blunder, and thus if possible put an end to its needless repetition.

Accordingly I took the matter up with Professor E. C. Buck, professor of anatomy in the Medical Department of the Ohio State University, and asked him to investigate his library of books on anatomy, and to make a study on the cadaver of this blood supply. He was kind enough to acquiesce, and a little

later at his invitation I went to his laboratory, where he had made a dissection on four fresh female cadavers, and he demonstrated again the correctness of my knowledge of the anatomy, and the inaccuracy of the textbooks. He also furnished me the following report as to this anatomical fact:

1. The artery of the round ligament of the uterus (the external spermatic in the male) is a small branch of the inferior epigastric. Its main stem descends through the inguinal canal with the round ligament anastomosing with branches of the external pudendal and, occasionally, with the prolonged funicular branch of the superior vesical. A small branch of this artery accompanies the round ligament inward and anastomoses with branches of the uterine, ovarian, and vesical, to the round ligament.

2. The uterine and ovarian arteries anastomose forming an arterial arch which gives off branches to the round ligament. These branches accompany the ligament outward anastomosing with funicular branches from one or more of the vesical arteries and a proximally directed branch from the artery of the round ligament.

3. The funicular artery, a branch of the superior vesical (artery of the vas deferens in the male) or occasionally, from the inferior vesical, is a small slender artery which accompanies the round ligament outward from the point the ligament crosses the artery, anastomosing with branches from the uterine, ovarian, inferior epigastric, and external pudendal. The branches to the round ligament derived from the uterine, ovarian, and vesical may give off proximally directed branches which extend inward to the attachment of the ligament to the uterus.

Any of the vessels to the round ligament may become enlarged in diseases of the uterus, ovaries, and tubes.

I have full records of more than three thousand abdominal hysterectomies in the course of which I have freely cut across the round ligaments, and in only one instance was there any arterial bleeding, and that from only one side. In that operation, which was done only a few days ago, the uterus was the seat of puerperal infection, with multiple abscesses in the left wall, and as I cut across the left round ligament there was a tiny spurt from the distal end which was at once controlled by a clamp. The hæmorrhage in this case was doubtless due to the inflammatory condition present, with its accompaniment of abnormally dilated blood-vessels, as suggested by Professor Buck.

It is to be hoped that with this authoritative demonstration, writers and operators will correct the error into which they have fallen, and save space in books and time in operating.

KRUKENBURG TUMOR

By T. L. CHAPMAN, M.D., Duluth, Minnesota
From material of the Duluth Clinic

THE article entitled "A Study of the Krukenburg Tumor," by Ralph D. Major, M.D., in SURGERY, GYNECOLOGY AND OBSTETRICS, August, 1919, convinces me that a recent case of this disorder should be added to the literature; partly because the case comes under the well defined group, over which there is no dispute, of solid growths of large size occurring in both ovaries, secondary to a much smaller growth in the stomach; and partly for the reason that a search of the records does not reveal any instance of this disease occurring in so young an individual. The average incidence of the disease, according to the analysis by Major of 55 cases, is 36 years, and the earliest occurrence of the disease reported hitherto, by Krueger[1] was at 19 years. My case was 14 years of age. Other features of interest in this instance are the remarkable size of the ovarian metastases, the unobtrusive symptoms from the stomach tumor, and its small size, and the very early death of the patient from exhaustion, following the removal of both ovaries.

The history of my case follows:

While on a vacation, Pearl S.....aged 14 years, was seen by me September 16, 1917, in consultation with a physician in the country. The purpose was to aid in the difficult removal of an abscessed tooth,

[1]Muenchen. med. Wchnschr., 1909, lvi, 3606.

and an anæsthetic was desirable. The physician informed me on the way, that the little girl was under suspicion of being pregnant, as she had increased in girth most unaccountably and rapidly, but no definite examination had been made. While the child was still under chloroform for the removal of the tooth, opportunity was given for a fairly complete manual examination, and questioning afterward elicited the history. She had had no severe illnesses in her life and had been considered very rugged and well grown. Both parents were Scandinavians and were in excellent health. There was no family history of malignant growths. The girl had menstruated 2 months before this date, for the first time, and had not since; enlargement of the abdomen had occurred about at the menstrual period mentioned, and had been rapid and continuous, so that she now was of the size of a woman at full term. The abdomen was very tense, the tumor mass nearly to the ensiform, and was very hard, with two fairly distinct large lobulations. The superficial blood-vessels were notably tortuous and enlarged; she had no pain, but was rather languid and inactive and appetite was lacking, though failure of flesh had not been notable. There had been about 2 weeks previously, a mild vomiting attack attributed to dietary source, and no other gastric symptoms.

No indications of pregnancy were found, the breasts and hymen being virginal, and diagnosis of solid ovarian tumor was made. Her parents consented to bring her to town for further examination and operation, and on September 20, 1917, she presented herself at this clinic. The blood picture showed only a secondary anæmia, red blood cells 3,700,000; hæmoglobin 60 to 70, and white blood cells 8000. The urine was normal, heart and lungs showed no pathology. Fluroscopy of stomach was not performed.

She was operated upon September 20, under ether drop-method anæsthesia, the incision just to the left of the umbilicus being employed, and extending from pubis nearly to ensiform. It was then found that there were two tumors, one from each ovary, both solid. Through even so extensive an incision they were delivered with difficulty; the enormously vascular pedicles ligated, and the growths removed. The growths weighed respectively 6 and 7 pounds.

A recollection that solid bilateral tumors of ovaries are nearly always malignant, caused me to search the abdomen for further information and there was found a growth the size of a dollar of definitely scirrhus-carcinomatus appearance and feel, on the lower edge of the anterior wall of the stomach, at the middle of the greater curvature. Very small metastatic glandular enlargements could be felt all through the gastrocolic omentum and more and somewhat larger ones over toward the liver, none was found elsewhere, and no more extensive pathology could be demonstrated. A small amount of serous fluid was found free in the abdominal cavity. As patient was badly shocked, no further surgery was deemed advisable. The abdomen was closed.

She recovered from her initial shock sufficiently to heal her wound in a space of 10 days and was sent home. A decline in her strength seemed constant, no hope was entertained that an improvement might occur, and nothing warranted an attack upon the source of the growth; she failed progressively and died October 10, 1917, apparently of exhaustion. No autopsy was performed, and she was not seen by us after leaving the hospital.

The pathological report gives the characteristic evidences of a true Krukenburg tumor, a diffuse myxomatous structure corresponding to an early German description "Gelert-Krebs." There was a connective-tissue stroma, in which were great numbers of round cells with nuclei eccentrically placed, giving the "signet-ring" appearance. There were some small areas that contained liquefaction cysts.

Although not universally conceded in this country, it is firmly held by some European pathologists, that the metastatic extension of this type of tumor, is entirely unique, in that it does not follow the usual routes of the lympatic channels or blood stream, but instead, is by direct implantation of cells from the primary growth, through the peritoneal cavity, by dropping of malignant cast-off cells, on to a much more susceptible and responsive tissue than that upon which the primary growth is supported. This probably accounts for the possible great size of the secondary growths while the original tumor may be almost negligible comparatively.

Certain features of the case reported, lend support to this opinion. The primary growth was small, the metastases enormous; and in spite of the fact that minor extensions from the stomach had occurred by the lymphatics over toward the liver, there was no macroscopical evidence of any lymphatic or vascular disturbances over these channels between the two main growths. The picture, therefore, coincides accurately with the indisputable and best authenticated type of the true Krukenburg tumor, whatever may be the facts regarding certain other questionable varieties in which ovarian metastases occur, but in which are not present the essentials of a primary growth in the stomach, early and rapidly growing metastases through the peritoneum, and the pathological complex set forth briefly above; and we believe that this case is the youngest recorded one in which these findings have been reported.

SOME PRINCIPLES INVOLVED IN THE TREATMENT OF EMPYEMA[1]

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TWO striking facts are apparent in the recent very extensive literature on empyema. In the first place, it is evident that methods of treatment commonly employed before the war have now been largely abandoned or changed; and in the second place, the treatment has become somewhat standardized with the result that there is a surprising agreement on all sides concerning the essential principles involved. The chief factor responsible for this change has been the extensive epidemic of streptococcus infections of the respiratory tract, with its resulting high incidence of empyema which ravaged the military camps of this country in the winter of 1917–18. It is not my intention in this article to dwell on the finer details but to discuss rather the rationale of the principles involved.

My good fortune in being appointed a member of the Empyema Commission enabled me to observe an unusually large number of cases, and this opportunity was supplemented by being placed in charge of 138 cases of chronic empyema at Fort Sheridan, Illinois, upon my return from France, in May, 1919. The principles of treatment which were advocated not only by the Empyema Commission but also by others were at the time and are even now challenged by some as being unsound; and the remarkable reduction in mortality which occurred when these principles were put into effect has often been accredited to a diminished virulence of the organism rather than to the changed methods of treatment. Accordingly it has seemed desirable to test out by experiment the soundness of these principles, and it is this phase of the question which will be chiefly discussed in this article.

The essential principles involved are as follows: (1) the avoidance of an open pneumothorax in the acute stage during the active pneumonia; (2) the early sterilization and obliteration of the cavity; and (3) the maintenance of the nutrition of the patient.

AVOIDANCE OF OPEN PNEUMOTHORAX IN ACUTE STAGE

The importance of the avoidance of an open pneumothorax during the acute stage of an empyema becomes more obvious when it is realized that the common conceptions of the mechanics of the thorax are incorrect. These conceptions have been based on the idea that in the normal chest the mediastinum constitutes a more or less rigid partition between the two pleural cavities and that when one lung is compressed either by air or fluid the other lung remains slightly, if any, altered. This conception has carried with it the idea that if an open pneumothorax is created, "collapse" of the lung on that side occurs and that respiration is carried on exclusively by the other lung. That this conception has become thoroughly ingrained in the literature may readily be seen by reference to the treatises of Emerson,[2] Sauerbruch,[3] L. Mayer,[4] etc. Garré,[5] as recently as 1911, has stated: "In open pneumothorax the collapsed lung is functionally completely shut out. With every inspiration the pressure in the two pleural spaces will be different: in the pneumothorax atmospheric pressure, on the sound side a negative pressure (7 milligrams mercury)." In a very recent article Moschcowitz[6], of New York, has reproduced diagrams which again express this common misconception by showing the mediastinum in open pneumothorax as a straight line, with one lung collapsed to a small mass about the hilum of the lung and the other lung of normal size.

As a matter of fact, however, it is easy to show by direct experiment that these conceptions are erroneous. Instead of consti-

[2]Pneumothorax. Johns Hopkins Hosp. Rep., 1903, xi, 1.

[3]Zur Pathologie des offenen Pneumothorax und die Grundlagen meines Verfahrens zu seiner Ausschaltung. Mitt. a. d. Grenzeb. d. Med. u. Chir., 1904, xiii, 399.

[4]Les Bases Physiologiques de la Chirurgie Pleuropulmonaire. Ann. d. l. Soc. roy. d. sc. méd. et nat., de Bruxelles, 1906, xv, 1.

[5]Pneumothorax Rapports du Troisiéme Congrés de la Société Internationale de Chirurgie, 1911, p. 1.

[6]Empyema, with particular reference to its pathogenesis and treatment. Surg., Gynec. & Obst., 1920, xxx, 35.

[1] Read before a joint meeting of the Chicago Surgical and Chicago Medical Societies, January 21, 1920. (For discussion, see p. 92.)

tuting a more or less rigid partition between the two pleural cavities, the mediastinum is actually so mobile that in the normal individual, from the standpoint of pressure relationships, the thorax may be regarded practically as one cavity instead of two. The resistance offered by the normal mediastinum to air pressure is equivalent to the pressure exerted by a column of water only 0.5 centimeters to 1 centimeter high (0.4 millimeters to 0.8 millimeters of mercury). It is therefore negligible.[1] Moreover, direct experiments immediately after death both on human cadavers and on dogs with normal thoraces show that the amount of resistance exerted by the mediastinum both in the human and in the dog is the same. It seems reasonable, therefore, to assume that phenomena observed experimentally on the living dog can be directly applied to the living human. (Figs. 1, 2 and 3.)

If an open pneumothorax is created on one side in the normal living dog, a characteristic response occurs which is manifested not only by a change of intrapleural pressure on the opened side but also by a change of the same kind and of practically the same degree on the unopened side. Briefly the phenomena which occur are as follows: Immediately after making the opening there is a simultaneous change of pressure in the two pleural cavities from an entirely negative (less than atmospheric) phase to one which is partly positive (more than atmospheric) and partly negative. The size of the opening, as will be shown later, materially influences the extent of the change of pressure. The respirations are sometimes slowed and increased in amplitude, but at other times they are accelerated. As the intrapleural pressure increases, the intratracheal pressure diminishes as would be expected, since the latter is a rough index of the amount of air passing down the trachea. Immediately upon closure of the opening there is a simultaneous response in both pleural cavities with more complete restoration of negative pressure, diminution of the amplitude of the respiratory movements and oscillations again of positive and negative intratracheal pressure on inspiration and expiration.

[1]For the details of these experiments see: Graham, E. A., and Bell, R. D. Open pneumothorax; its relation to the treatment of empyema. Am. J. M. Sc., 1918, clvi, 839.

A priori it would seem to follow from all this that in the normal chest an open pneumothorax on one side would produce practically an equal amount of compression of both lungs and that the prevalent conception of collapse of one lung with maintenance of respiration by the other must be incorrect. Again, direct experiment seems to confirm the truth of this conclusion; for determinations of the relative densities of the two lungs after altering the pressure in one pleural cavity show that, within the range of experimental error, the densities are the same and therefore that both lungs are practically equally compressed. The extreme mobility of the human mediastinum in the absence of adhesions has been shown in X-ray studies by Stivelmann and Rosenblatt.[2] Their work tends to confirm the truth of the general idea here being developed, of the practical equilibrium of pressure throughout the normal thorax.

The older conceptions of the immediate establishment of atmospheric pressure within a pleural space as soon as an open pneumothorax is created fail to take into consideration the fact that the thorax, instead of being a rigid box, has movable walls which by varying the size of the contained space also vary the pressure within it. If the older conceptions were correct, then a small opening into the chest would have the same consequences as a large one because in each case "collapse" of the corresponding lung would occur. It would follow from this also that in a normal chest a unilateral open pneumothorax ought never to be fatal regardless of how large the opening might be, since the worst possible consequence would be the "collapse" of one lung. Similarly, also, with the same line of reasoning, a bilateral open pneumothorax should always be promptly fatal. Experiences, however, both experimental and in the war, which controvert these two conclusions, have been many, and it is also easy experimentally to demonstrate that there is a definitely quantitative relationship which exists, in any individual with a normal thorax, between the size of the opening in an open pneumothorax and the danger of death. One of the impor-

[2]Protrusion of artificial pneumothorax into the opposite untreated side. J. Am. M. Ass., 1919, lxxii, 1445.

tant factors in this calculation is the "vital capacity." One who has a "vital capacity" equal to the average (3,700 cubic centimeters) can withstand an opening of an area of a little more than 8 square inches (51.5 square centimeters), and one whose "vital capacity" is as much as 7,180 cubic centimeters (as in a case described by Peabody and Wentworth[1]) can withstand an opening as large as about 15.6 square inches (101.3 square centimeters).[2] It makes practically no difference whether the opening is unilateral or bilateral, provided the combined area of the openings does not exceed the calculated amount for the limits of safety. On the other hand, a low "vital capacity" predicates a small opening; and if the "vital capacity" becomes so low that it equals the "tidal air" of the individual then he will be unable to withstand an opening of any size. The reasons for this quantitative relationship are to be found in the facts that: (1) it is possible to maintain life as long as the lungs can inspire the "tidal air," which normally is from 300 cubic centimeters to 500 cubic centimeters; (2) a considerable encroachment on the volume of the two lungs can be made before any interference with the tidal air occurs; and (3) in the compensatory reaction, by an increase in the amplitude of the respiratory movements the thorax is enlarged so that actually more air may enter through the pneumothorax opening without encroaching on the tidal air to the same extent than if the thorax were not enlarged.

It must be particularly emphasized that this consideration of the practically negligible resistance of the mediastinum with the associated equality of pressure throughout the thorax refers only to the normal thorax. Obviously, a thickening of the mediastinum by old inflammation and the presence of strong adhesions will change the conditions and will allow the development of a considerably greater pressure on one side than on the other.

In acute empyema, particularly of the type due to hæmolytic streptococci, practically all the factors are present which make for a low "vital capacity" and therefore make a free opening in the chest wall particularly dangerous. When it is recalled that clinically these patients, during the early stages, are usually cyanotic and that they are often suffering from air-hunger to a marked degree, it is evident that they already are having extreme difficulty to obtain their "tidal air." In other words, they represent a condition in which the "vital capacity" is practically equal to the "tidal air." Even a tiny opening in the chest wall in such a condition will often be fatal because it will not be possible to encroach any more upon the air space of the lungs without causing death. The reason for this becomes all the more clear when one considers that the essential pathology in this condition not only concerns the actual involvement of a considerable proportion of alveolar space by the pneumonic process but also a rather extensive occlusion of many of the bronchioles both by actual plugging with exudate and by œdema. If, on the contrary, an opening is made later, after the subsidence of the pneumonia, the situation will be very much more favorable. The "vital capacity" will have been considerably increased, as evidenced by the lack of cyanosis and dyspnœa, so that a much larger opening can be made without the same consequences of an open pneumothorax made earlier; and also, limiting adhesions will usually have formed so that instead of creating an open pneumothorax, in the sense of allowing air to enter the free pleural cavity, the opening will usually lead into a circumscribed abscess. The question of whether an early operation to accomplish drainage by a closed method, without the admission of air, or whether merely frequent aspirations should be carried out until the subsidence of the pneumonia seems to me to be relatively unimportant. Each method has certain advantages over the other. The important matter is to avoid the creation of an open pneumothorax.

On the other hand, the situation in regard to pneumococcus empyema is very different. Usually by the time the pleural effusion has become recognized the active pneumonia has subsided so that we are dealing with conditions for operation which we attempt to create

[1] Clinical studies of respiration. IV. The vital capacity of the lungs and its relation to dyspnœa. Arch. Int. Med., 1917, xx, 443.

[2] For the derivation of the mathematical expression which yields these results see previous article by Graham and Bell, (loc. cit.), and also Graham, E. A., The maximum non-fatal opening of the chest wall. J. Am. M. Ass., 1919, lxxiii, 1934.

when we delay the establishment of open drainage in the streptococcus cases. For this reason alone a knowledge of the bacteriology in a given case is of the greatest importance, in addition to the fact that experience has shown that the prognosis is very much more favorable in the pneumococcus than in the streptococcus cases.

Also other effects of an open pneumothorax than the production of direct asphyxia are important. The danger of infection of a clean pleura or of secondary infection of one already infected is so great that it is almost impossible to avoid unless special precautions are taken (as, for example, in the latter case, the use of Dakin's solution). Another serious effect of an open pneumothorax is loss of heat. Sauerbruch[1] already has shown that this may be enormous, and in the case of rabbits may amount to as much as 3.5° C. within 45 minutes. In dogs the amount of heat lost by means of an open pneumothorax per unit of time may be greater than occurs with an extensive laparotomy and eventration of the intestine. Marked disturbances in the general circulation also may occur. Sauerbruch has summarized these by saying: "In pneumothorax the aspiration of the heart fails; a stasis results in the venous system. Measurements of the venous pressure in the femoral vein give, in fact, an increase of the pressure." As a rule there is no noteworthy change in the arterial pressure. When asphyxia occurs there is evident a rise in the carotid pressure, as might be expected. Sackur[2] claims to have found a marked diminution in amount of oxygen in the blood, in some instances to only one-half.

It is readily apparent, therefore, that the dangers inherent in the creation of an open pneumothorax in the pneumonic or developmental stage of an empyema are so great as to be unwarrantable.

EARLY STERILIZATION AND OBLITERATION OF THE CAVITY

The second cardinal principle in the treatment is the early sterilization and obliteration of the cavity. No case can ever properly be considered as healed until the cavity is both sterilized and obliterated. The tendency rather frequently advocated by recent writers of closing empyema cavities after they have become sterile, regardless of the size of the air-pocket contained, will yield brilliant results in certain cases, but this procedure is bound to lead in many instances to recurrences and to a prolongation of invalidism.

In Dakin's solution (0.5 per cent neutral sodium hypochlorite), the war has furnished us with an agent which seems theoretically to be ideal for accomplishing this dual purpose. It provides a method which apparently is a distinct improvement over previous methods; for not only does it exert a distinct sterilizing power but also by its property of aiding in the solution of necrotic tissue it acts also as a decorticating agent. Nothing is more striking in the recent extensive literature on empyema than the almost unanimous agreement on the effectiveness of Dakin's solution in the rapid accomplishment of sterilization and obliteration of empyemic cavities. The details of its use have been given so frequently as to make their repetition unnecessary in this article.[3]

The failure of these cavities to obliterate themselves promptly is due chiefly to an inability on the part of the lungs to expand sufficiently to fill completely those portions of the thorax not occupied by other structures. If no adhesions were present and if the mediastinum were not thickened by inflammatory induration, the cavity could still be obliterated, even if the lung on the affected side were considerably smaller, by the readjustment accomplished by the extension upward of the diaphragm on that side and by the pushing over of the lung of the unaffected side into the affected pleural space. But adhesions always are present so that probably it is necessary for the lung on the affected side to expand itself more than would be the case if the mediastinum retained its normal mobility. The inability of that lung to expand is dependent chiefly on three factors: (a) fibrosis of the lung as a result of inflammation; (b) obstruction of bronchioles, as a result of

[1] Loc. cit.

[2] Weiteres zur Lehre von Pneumothorax. Arch. f. path. Anat. u. Physiol., 1897, cl, 151.

[3] See, for example, the report of the Empyema Commission: Cases of Empyema at Camp Lee, Virginia. J. Am. M. Ass., 1918, lxxi, 366 and 443.

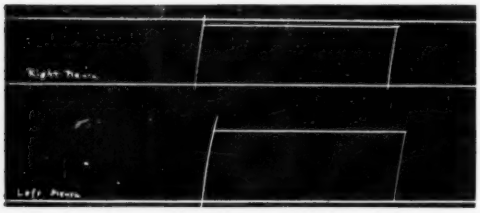

Fig. 1. Tracing showing that when the left pleural cavity of a fresh adult human cadaver is inflated with air at a pressure of 10 centimeters of water, the right pleural cavity registers a pressure of 9 centimeters. The top line is a record of a pressure of 10 centimeters made with the tambour attached to the right pleural cavity. Calibration showed that the actual pressure was 9 centimeters of water.

the inflammatory reaction, which prevents the entrance of air into portions of the lung with a consequent atelectasis of those portions; and (c) the thick, inelastic coat of exudate which covers the exposed surface of the lung and limits its inflation.

Evidence of failure of the lung to expand properly is presented at autopsies on cases of unhealed empyema. It is revealed by finding that the lung on the affected side is smaller than the opposite one, and that the exposed surface of the lung is coated with a dense layer of exudate which is sometimes fibrinous and sometimes organized connective tissue, in association frequently with a lake of pus contained within the thorax. The inequality in the size of the two lungs has frequently been ascribed to the collapse of the lung on the opened side from an open pneumothorax, and it has even been used as an argument against the validity of the conclusion of the equilibrium of pressure throughout the normal thorax as developed in that part of this article which deals with the experiments on intrapleural pressures. It seems more probable, however, that there are other explanations. As MacCallum[1] has pointed out: "Widespread necrosis occurs with final destruction of areas of lung substance." As this necrotic lung tissue is removed by expectoration and by gradual absorption, a considerable amount of fibrosis must occur during the healing process, which must necessarily result in the lung being smaller than normal. At the same time the opposite lung may undergo hypertrophy, since the presence of long standing adhesions and inflammatory induration have immobilized the mediastinum to such an extent that the "healthy" lung is no longer subjected to compression by slight changes of pressure in the affected pleural cavity. The remaining air-containing portions of the affected lung, however, are not able to undergo hypertrophy to the same extent as they might otherwise do because of the thick coat of organized inelastic exudate which inhibits an adequate inflation of this lung.

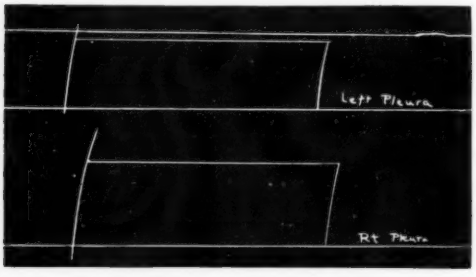

Fig. 2. A similar tracing with the right pleural cavity inflated. Calibration showed that in this case also there was a difference in pressure of only 1 centimeter of water (about 0.8 millimeters of mercury).

Fig. 3. Tracing made in the same way with a recently killed dog which shows that the dog is strictly comparable with the human, since here also the difference in pressure between the two pleural cavities amounted to only 1 centimeter of water.

It is obvious, therefore, that the early removal of this corset-like membrane around the lung is highly desirable. Because, at least in the streptococcus cases, organization of this exudate is known to occur early, it is clear that, other things being equal, the longer the exudate is allowed to remain on the lung, the longer time will be required to obliterate the cavity. For the cavity is obliterated only

[1] The pathology of the pneumonia in the United States Army camps during the winter of 1917-18. Monographs of the Rockefeller Institute for Medical Research, No. 10, 1919.

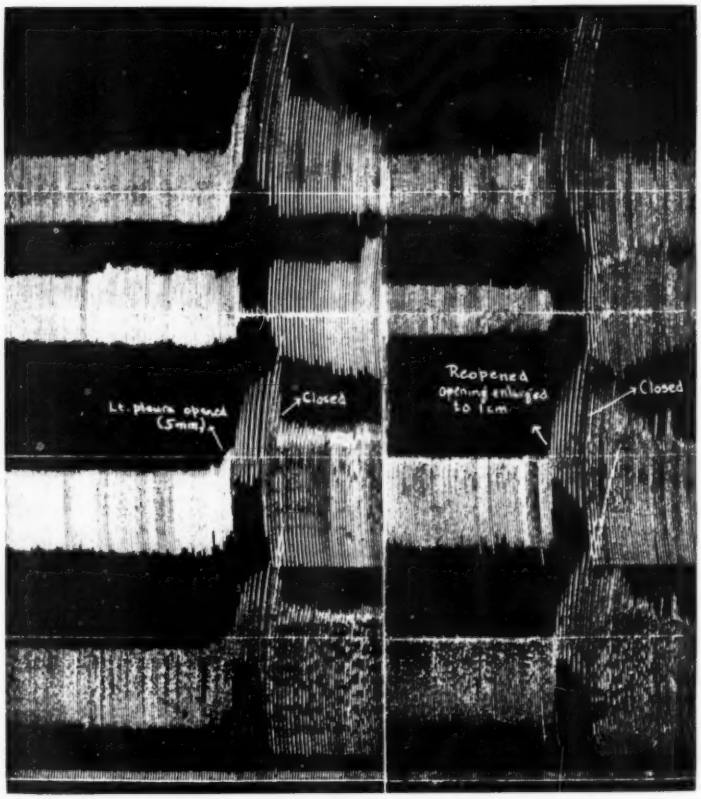

Fig. 4. A tracing made on the living dog under ether anæsthesia to show the nature of the reaction to an open pneumothorax with a moderate opening, as indicated in the changes in the respiratory movements, in the tracheal pressure and in the pressures in both pleural cavities. The upper tracing represents the respiratory movements, the next the tracheal pressure, the third the left pleural pressure and the fourth one the right pleural pressure. The lowest line indicates the time in seconds. The base lines were drawn at atmospheric pressure. The break in the chart represents an interval of six minutes. Immediately after making the opening there is a simultaneous change of pressure in the pleural cavities from an entirely negative phase to one which is mostly positive. The respirations are slowed but are increased in amplitude. If the experiment is performed with local anæsthesia, however, the respirations are accelerated as well as being increased in amplitude, after making the opening. Because the intrapleural pressure is largely positive, practically no air enters the trachea and the intratracheal pressure tends to be at equilibrium with atmospheric pressure. Immediately upon closure of the opening there is a simultaneous response in both pleural cavities, with restoration of negative pressure to a large extent, diminution of the amplitude of the respiratory movements and oscillations again of positive and negative intratracheal pressure, with inspiration and expiration. After an interval of 6 minutes, during which time probably most of the air in the pleural cavities has been absorbed, the intrapleural pressure has again become entirely negative.

when the lung is in contact everywhere with the parietal pleura. In the past, recourse has been had chiefly to mechanical means for the accomplishment of this purpose, as, for example, operations of the type devised by Delorme but, although in some cases they have yielded

brilliant results, on the whole they have been unsatisfactory. They have been associated with a high mortality and frequently they have not cured the patient. The fundamental defect in the rationale of such procedures is that attention is directed to only one of the two main objects of the treatment of empyema; namely, only to the obliteration of the cavity. It is fully realized of course that nature's efforts at sterilization are greatly aided by the obliteration of the cavity, but the frequency with which empyema recurs after the lung has apparently expanded to fill up the pleural cavity is evidence of the desirability of more active efforts directed toward the sterilization of the cavity.

As a rule the Dakin's solution decorticates the lung gradually, apparently by a solution of the exudate. In some cases, however, this membrane seems to be removed in one large mass suddenly or in several smaller pieces. As an evidence of the apparent remarkable decorticating ability of the hypochlorite solution, a résumé of a striking case is here given.

Pvt. G., age 22, was wounded in arm and leg in October, 1918. He developed a pneumonia on the left side followed by empyema in November. Drainage was accomplished through a thoracotomy incision. When first seen by me on June 2, 1919, at U. S. A. General Hospital 28 at Fort Sheridan, Illinois, he had a small opening in the seventh interspace in the left posterior axillary line which was draining a considerable amount of pus, containing large numbers of hæmolytic streptococci. According to the patient's own account Dakin's solution had been used on him occasionally but never systematically, at some of the various hospitals in which he had been. He was markedly underweight, had a septic appearance and had an afternoon temperature which ranged from 101° to 102°. He had entirely recovered from the wounds of his extremities. A measurement of his empyemic cavity showed that it had a capacity of 350 cubic centimeters, and the patient stated that a measurement which had been made 2 months previously had showed the same capacity. Under local anæsthesia a portion of the seventh rib was resected, and immediately after the operation instillations of 200 cubic centimeters of Dakin's solution at two hour intervals were begun with provisions for adequate free drainage. On the sixth day a large piece of tissue was found plugging the drainage opening. A photograph of this tissue after it had been hardened in formalin is reproduced here. A description of it will be given later. Two days after the expulsion of this tissue the empyemic cavity held only 35 cubic centimeters of fluid instead of 350 cubic centimeters and no growth of bacteria was obtained from the secretion. Ten days later he was entirely healed and examination both by ordinary physical means and with the X-ray revealed no cavity remaining. On August 28 he returned from a month's furlough, apparently entirely well and having gained 35 pounds in weight. Two months later I heard from him again, and he was still entirely well. The rapid decortication with later sudden expansion of the lung to fill the cavity such as happened in this case is unusual, but yet I have observed it several times.

This piece of tissue was irregular in outline and flat. In longest diameter it measures nearly 6 centimeters and in widest diameter about 3 centimeters. It was nearly 0.5 centimeters in thickness. It was slightly yellowish-white, smooth except for folds in its surface, and in gross appearance it closely resembled fibrin. In fact it was considered to be fibrin until sections for microscopic examination were made. The microscopic examination, however, showed that the main portion consists of necrotic organized tissue. Except for a narrow strip of inflammatory tissue which evidently indicates the side attached to the lung the whole section is occupied by bands of wavy fibrils, arranged parallel to one another, with here and there the faint remaining outlines of what apparently have been blood vessels. The absence of nuclei except in the inflammatory zone is striking. These fibrils are readily stained by Van Gieson's stain for connective tissue, but they are not stained by Weigert's method for fibrin. Undoubtedly, therefore, the tissue is chiefly fibrous connective tissue which has become necrotic and is not unorganized fibrin. Throughout the inflammatory zone, and occasionally in the area just beyond, are seen irregular clumps of organisms. Many of these can be clearly distinguished as streptococci, and they are gram-positive. The accompanying illustrations (Figures 5, 6, 7 and 8) show the principal features of this tissue which have been discussed here.

The striking feature of this case is that the decortication of a considerable amount of organized exudate from the surface of the lung was accomplished quickly and easily with Dakin's solution, and that its removal was followed by an amazingly rapid expansion of the lung.

It is, of course, clear that any method of treatment which will accomplish the two principal objects of sterilization and obliteration of the cavity in the shortest time and in the greatest proportion of cases is the method of choice. It is felt, furthermore, on the basis of the extensive experience afforded by the large number of cases of empyema in the army, that a careful avoidance of an open

Fig. 5.

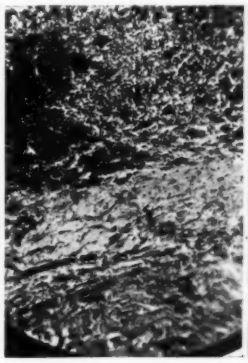

Fig. 6.

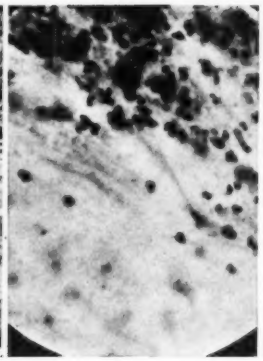

Fig. 7.

Fig. 5. Photograph of membrane of old fibrous tissue removed from the lung by the decorticating action of Dakin's solution. For description see text.

Fig. 6. Low power microphotograph of section of piece of tissue shown in Figure 5. Note the zone of inflammatory tissue next to the lung and the bands of connective tissue in the peripheral portion.

Fig. 7. High power microphotograph of a portion of the zone of inflammatory tissue.

pneumothorax in the acute stage and the intelligent and systematic use of Dakin's solution will not only strikingly reduce the high mortality but will also make chronic cases relatively rare. Either of these accomplishments will more than justify the substitution of those principles for older existing methods.

At this point it may be appropriate to call attention to certain facts concerning the common operations for the cure of chronic empyema. These operations are based chiefly on the idea of the desirability of obliterating the cavity, recognizing the well-known fact that it is all but impossible to maintain in a sterile condition a cavity surrounded by more or less rigid walls, particularly if it communicates with the outside air. In general two different methods of operative procedure are available, either (1) enabling the lung to expand to fill the cavity by removing its restricting membrane of exudate or (2) allowing the chest wall to collapse to meet the lung. The first of these which is comprised in the Delorme type of operation has already been briefly discussed. The second method is employed in operations of the type of Estlander, Schede, etc. It is chiefly this second method which will be discussed here.

Collapsing operations have many important disadvantages, as every surgeon well knows. These operations are accompanied by so high a mortality that from this standpoint they constitute some of the most formidable in the surgical repertory. They are always very mutilating in character, and they do not by any means always result in healing, even if the patient survives the immediate risk of death from the operation itself.

The extent of the mutilation induced by these operations has received almost no attention. The anatomic mutilation with its very bad cosmetic effect is of course readily apparent. The physiological deficiencies, however, which are probably made permanent by these operations, I have been unable to find discussed anywhere. It is this latter phase which has particularly interested me, and recently the opportunity has presented itself for a study of this aspect. Typical results are illustrated in the following case.

A young unmarried woman, age 28, recently came under my care because of a small discharging sinus in the left side of the thorax. She stated that in the winter of 1918 she had a bronchopneumonia followed by an empyema of the left side for which a portion of one rib was resected while she was still very ill. No irrigations of any kind and no suction apparatus were used. She continued to drain, and about three months later a partial Schede operation was done which consisted in the extensive removal of four ribs. This failed to result in healing and two months afterward (about June, 1919), two or three more ribs were removed. Following the last operation

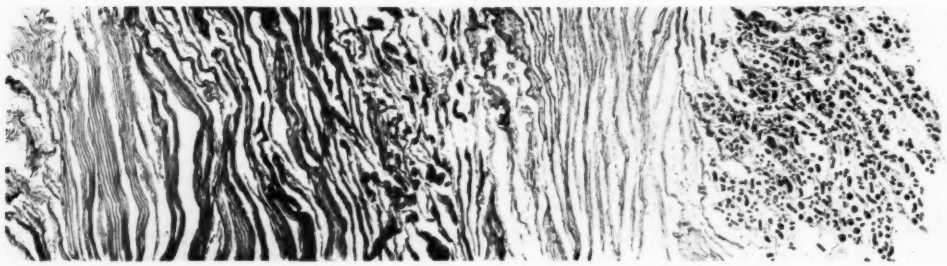

Fig. 8. Drawing to show the necrotic connective tissue next to the inflammatory zone. This necrotic connective tissue was readily stained by the Van Gieson method and was not stained by Weigert's stain for fibrin.

she was treated sporadically with what was said to be "Dakin's solution." Still, however, she continued to drain pus. At the time of my examination it was observed that from 4 to 6 inches of each of the ribs from the third to the tenth had been removed from the lateral aspect of the left thorax. The usual apparent deformity resulting from such a procedure was present. In the mid-axillary line at a level corresponding to about the sixth rib there was a small sinus from which pus issued. When a probe was inserted into the sinus it was found to pass upward and inward for a distance of about 3 inches, and when an attempt was made to irrigate the sinus a communication with the lung was discovered which resulted in coughing and in expectoration of the fluid. The chief matter of interest, however, in this connection is that measurements of her vital capacity gave a reading of only 1,600 cubic centimeters with a Krogh spirometer. Her height was 5 feet, 7 inches. When we compare this value with the table of vital capacities for normal women, as given by Peabody and Wentworth, we find that instead of having a value of 3,275 cubic centimeters, which is the normal average of women of her height, she had only about one-half of this capacity. It is interesting also that, as is usual, in spite of her diminished vital capacity, the readings for the tidal air were normal, 400 cubic centimeters.

The importance of this marked reduction of vital capacity in this patient after having had a Schede operation is very great; for it means that she is left in so mutilated a condition that in all probability if she ever has pneumonia, a pleural effusion, a disturbance of her heart, or any other condition which lowers the vital capacity she will have only about a 50 per cent chance of recovery as compared with what she would have if her vital capacity were normal. Besides this permanent physiological defect, she is still unhealed, she has a bad anatomical deformity and she is almost a psychopathic patient because of worry about herself. It is felt, on the contrary, that the application of the leading principles which are under discussion in this article will practically prevent the necessity for these mutilating operations. It is remarkable how the intelligent use of Dakin's solution, combined with proper drainage and with suitable exercises to promote expansion of the lungs, such as blowing against resistance, calisthenic exercises, etc., will obliterate a cavity in the chest which is so large that obliteration without operation seems hopeless. This fact has impressed itself forcibly upon all who have used these methods intelligently and conscientiously. I have seen, for example, a cavity of a capacity of 1,400 cubic centimeters which had remained stationary for three months become entirely obliterated with permanent healing by the application of these methods. This fact is forcibly emphasized in the report of the Empyema Commission: "The increased expansion of the lung following the use of Dakin's solution leads to the hope that extensive intrathoracic operations, such as decortication of the lung, may in most cases prove unnecessary. Such procedures should be undertaken only after most prolonged efforts to obtain expansion of the lung have failed." In the great majority of cases which fail to respond to this treatment some other factor than an ordinary empyema will be found responsible for preventing the healing, such as the presence of a foreign body, or tuberculosis. In 138 cases of chronic empyema at Fort Sheridan, 10 per cent were found to be tuberculous. Stevens,[1] also a

[1] Recurrences after operations for empyema. J. Am. M. Ass., 1919 lxxiii, 813.

Fig. 9. Photograph of a dog which had been injected into right pleural cavity with a solution of agar while alive but under ether anæsthesia. The agar solution was run in slowly until the animal died. The abdomen was opened, before beginning the experiment, by a median laparotomy incision to show the bulging downward of the diaphragm with the associated pushing downward of the liver. It will be noted that, although the agar solution was introduced into the right pleural cavity, the left diaphragm bulges downward and the liver is pushed down on the left side as well as on the right.

Fig. 10. Same dog as shown in Figure 9. Immediately after death it was placed in a refrigerator for 3 hours to allow the agar to solidify, and the chest wall was then opened as shown in the photograph. *a*, represents the right pleural cavity, which was found to be of practically the same size as the left pleural cavity, *c*. At *b* is shown the mass of solidified agar which occupied most of not only the right pleural cavity but also pushed the mediastinal structures over into the left side of the thorax. At *d* is the heart which nearly touched the left lateral wall of the thorax. *e*, shows the liver. The right lung was found encased in the agar and lying against the posterior wall instead of being contracted into a small mass about the hilum, as is generally supposed to happen when the lung is compressed. The left lung was also crowded against the posterior wall by the bulging over of the heart and other mediastinal contents. This experiment affords striking confirmation of the idea of practically an equality of pressure throughout the normal thorax at all times.

member of the Empyema Commission, made a study of the comparative results of treatment with and without the use of Dakin's solution in a series of 123 cases of empyema. The following figures, quoted from his article, show that the percentage of recurrences which follow the Carrel-Dakin treatment is only one-half of that which occurs when simple drainage is used:

Of 56 cases healed under simple drainage, there were 14 recurrences, or 25 per cent; of 67 cases healed under Carrel-Dakin treatment there were 8 recurrences, or 12 per cent.

MAINTENANCE OF THE NUTRITION OF PATIENT

The third cardinal principle in the treatment of a case of empyema, as in any acute infection, is the maintenance of the nutrition of the patient. In this connection R. D. Bell,[1] of the Empyema Commission, has made some very important observations. Briefly, he found that unless special attention is paid to the nutrition of these patients they are likely to have a negative nitrogen balance amounting to a deficit of as much as 21 grams per day. A negative nitrogen balance was

[1] These are published in detail in the report of the Empyema Commission, to which reference has already been made.

always found if the diet consisted of only 1,500 or 1,700 calories per day. If a patient is losing in his excretions 21 grams of nitrogen per day more than he is taking into his body as food, it is not surprising that he loses rapidly in weight. Obviously if this negative nitrogen balance continues very long, the disadvantageous effects of starvation are added to the handicaps under which he is already laboring in his efforts to combat a serious infection. If, however, the food intake is pushed so that he has a mixed diet containing from 3,300 to 3,500 calories per day, his nitrogen balance will be positive and he will usually gain in weight instead of lose. It is very interesting in this connection that Bell found that the average daily loss of nitrogen in the pleural exudate in patients who were aspirated amounted to only about 2 grams, as compared with from 20 to 30 grams in the urine.

The advantages of preventing loss of weight and emaciation are so obvious that they scarcely need comment. Emphasis should, however, be placed on the fact that it is perhaps as important a duty on the part of the surgeon to see that these patients are taking a sufficient quantity of food as to attend to any other part of the treatment of empyema. Undoubtedly many fatalities as well as the transition of some cases from an acute to a chronic stage are due to the neglect of this important feature. Difficulty in persuading patients to take a sufficient amount of nourishment is usually encountered only during the period in which they have fever. With the subsidence of the fever the appetite usually returns promptly. But even during the febrile stage a very considerable amount of nourishment can be given to patients easily by the administration of liquids. A particularly effective way to get large amounts of carbohydrates into such patients is by the administration of drinks containing lactose, since this sugar is not sweet and has so little taste that it may be easily disguised by the presence of fruit juices, etc.

SUMMARY AND CONCLUSIONS

The extensive recent literature on empyema reveals both a striking tendency toward a more or less standardized treatment and a radical departure from methods in use prior to the war.

The cardinal principles of (1) the avoidance of an open pneumothorax during the acute pneumonic stage of the disease, (2) early sterilization and obliteration of the cavity, and (3) the maintenance of the nutrition of the patient, are discussed in this article.

It is shown that the former prevalent conceptions of the mechanism of action of an open pneumothorax are incorrect.

In the normal thorax the mediastinal structures, instead of constituting a more or less rigid partition between the two pleural cavities, are in reality so mobile that to air pressure they offer a resistance which is equivalent to the pressure exerted by a column of water only 0.5 centimeters to 1.0 centimeter high (0.4 millimeter to 0.8 millimeter of mercury). This resistance is therefore negligible and from the standpoint of pressure relationships, the thorax can be considered as one cavity instead of two. Any change of pressure, therefore, in one pleural cavity will manifest itself to practically the same degree in the other pleural cavity with the result that both lungs will be about equally compressed. The situation in this respect is the same in the dog as in the human, and, therefore, experimental results obtained on the dog can be directly applied to the human.

The likelihood of a fatal asphyxia as a result of an open pneumothorax depends upon a number of factors, important ones of which are the size of the opening and the vital capacity of the individual. A mathematical expression has been devised by which it is possible in a given case to approximate the maximum non-fatal opening in the chest wall if the vital capacity is known. One who has an average vital capacity (3,7000 cubic centimeters) and a normal thorax can withstand an opening in the thoracic wall of 51 square centimeters (8 square inches), but the individual of exceptional vital capacity (as, for example, 7,100 cubic centimeters), can live with an opening of 101 square centimeters (15.6 square inches). A bilateral open pneumothorax is practically no more dangerous to life than a unilateral opening provided that in each case the areas of the openings are the

same. If the vital capacity is so low as to approximate the tidal air, even a very small opening may be fatal.

As shown in the text, these observations have a very important bearing on the question of open drainage of cases of empyema, particularly during the acute pneumonic stage when the vital capacity is low. After adhesions have formed and the mediastinum has become somewhat stabilized, both by adhesions and inflammatory induration, then the pressure relationships may be materially different on the two sides.

Effects of an open pneumothorax other than those directly upon the lungs are briefly considered, such as heat loss, changes in the systemic circulation and danger of infection.

The value of Dakin's solution in sterilizing and obliterating empyemic cavities is shown, as well as its power to decorticate lungs.

Collapsing thoracoplastic operations have the disadvantage, even when successful, of apparently premanently reducing the vital capacity.

The maintenance of the nutrition of the patient is of fundamental importance.

DIET IN PREGNANCY[1]

By CHARLES E. PADDOCK, M.D., F.A.C.S., Chicago

IS the average diet of the non-pregnant woman sufficient to supply the nourishment necessary in pregnancy? This question has been answered quite definitely that it is by a number of physiologists who claim to have demonstrated the fact by animal experimentation. While experiments can be made upon animals it is impossible to demonstrate in the same way upon the human, although the obstetrician can substantiate the claims of the scientific observer by clinical evidence which shows that during pregnancy there is tissue growth except when the patient is on a low starvation diet.

The gain in body weight of the mother, fœtus, etc., at this time, amounts to between 20 and 30 pounds by the termination of the pregnancy; this amount is considered a normal increase. During the last 3 months there is a gain in weight of from 3 to 5 pounds a month. This gain is equally divided between the mother and the fœtus with the uterus and its contents. Such gain in weight takes place in all mammals, and is the wise provision of nature for storing sufficient nourishment for the needs of pregnancy and to meet the natural loss during labor and the puerperium.

However, in the first 3 months of pregnancy, the balance of gain is negative, either in the weight or in the storing of nutritive elements. The reason for this is that in the first few months of pregnancy, a large percentage of women are either nauseated or vomiting, or have such a distaste for food that they cannot eat. Under such disadvantage there must be a loss in material tissue building. The ovum at this time, in spite of being the cause of all the trouble, is a negligible quantity when it comes to exacting nourishment from the mother. In fact, the latest theory is that the impregnated ovum for a time at least is an independent organism, and different from the ordinary maternal cell, and capable of looking out for its own nourishment during its early development. This period of negative balance is that of the placental formation. During this time there is often a net loss in nitrogen metabolism, and then comes a period in which the old and the new organisms become accommodated one to the other. At this time it will be necessary to increase the amount of food taken by the mother until the normal condition is established. Now begins a period of storing nutrient substances in the tissues of the mother.

The increase in tissue outside of the uterus is mostly in the pelvis and abdominal walls, but also there is a general increase in all the tissues. One would think this increase in tissue would call for a greater amount of food,

[1]Read before the Chicago Gynecological Society, Feb. 20, 1920. (For discussion see p. 95.)

but it doesn't. We can compare the added weight to a neoplasm or to an individual taking on more weight without any apparent reason. Observation up to the present seems to prove that the above statement is true, and future experiments undoubtedly will add facts to these observations.

But the question arises, does the fœtus suffer from the malnutrition of the mother, and can we influence its growth by a special diet prescribed the mother?

Previous to the experiments of Prochownick, published in 1889, very little was written upon the diet during pregnancy, and as the subject is never discussed without some reference to Prochownick and his theories, let us consider what he says for a moment. His theory is that by placing the patient upon a protein diet, and limiting other foods, the weight and size of the fœtus at term can be lessened.

Proteid material in some form is in all the food we eat. It is in cereals, in vegetables (peas and beans contain large quantities) in fish and fowl, in milk, etc. It is easily seen, then, that it is almost impossible to get away from proteins, and while they are necessary, if taken in excess, make toxic conditions.

So Prochownick evolved the theory that by limiting the carbohydrates he could limit the amount of the fat of the baby's scalp and sutures of the head, and by so doing in part stop the growth of the soft tissues without affecting the bony structure of the head. In this way he thought there would be freer overlapping of the sutures and a definite molding of the head at delivery. With the facts from 1889 before us, it seems to me that all we get out of the experiments and beliefs of Prochownick is the fact that he brings up the subject of diet of pregnancy, and thus brings an important question definitely before us. Prochownick was right in trying to find some way to control the size of the child and thus lessen infant mortality at birth, for at the time of his activities it was customary to bring on premature labor, even at the seventh month in cases of contracted pelvis, or later, to perform a craniotomy upon the living child.

However, the concensus of opinion is, that the food taken by the mother has little, if any, effect upon growth of the fœtus, and that the fœtus will thrive at her expense even if she is below par.

Not infrequently articles appear in the medical journals in which the diet advocated by Prochownick is recommended, in spite of the fact that there are no settled facts to substantiate the theory. And textbooks of this country, while not altogether advising the treatment, say it is worthy of trial. Besides, many physicians agree with the textbooks that the diet is worth at least a trial.

Here are a few quotations from some who accept Prochownick's theory:

Cragin says: "As advocated by Prochownick and others, if the patient has previously borne very large children, or the pelvis is slightly contracted, the size of the child may be reduced without injury by having the patient during the last few months of pregnancy take less than the ordinary amount of carbohydrates, less fluid with her meals and rise from the table with appetite not entirely satisfied. In this way the labor in some women is rendered easier."

Williams advises that in slight degree of pelvic contraction, or in a patient who has previously given birth to excessively heavy children, a restricted diet may be advisable during the last 2 or 3 months of pregnancy. The larger size of the children in the well-to-do classes is in great part attributable to the life of ease and the abundance of food enjoyed by the mother; and here he refers to the work of Prochownick as confirmed by Paton and Reeb and evidently agreeing with these men that "a diet poor in carbohydrates and fluids exerts considerable influence in lessening the weight of the child without otherwise affecting it."

Other physicians do not approve of the Prochownick theory.

Slemons says there can be no justification for measures intended to restrict the growth of the fœtus, for when rigidly carried out such measures tend to weaken the mother.

In a recent article, E. P. Davis writes: "The largest baby coming under observation was delivered by embryotomy from a primipara whose appetite had been unrestrained during pregnancy and who had eaten freely of meat

four times a day." Continuing, he says: "Unquestionably excess in protein diet produces a larger and overgrown and unduly hard fœtal skeleton."

Ehrenfest says: "The fœtal abstraction of the nutritive material from the mother proceeds entirely independent from the nutritive condition of the mother."

Evvard's experiments of adding meat meal to the ordinary ration of corn and alfalfa, fed to guinea pigs, resulted in producing a larger boned and stronger litter. He had the same results from his experiments upon sheep.

With such reports before us, what can we say of the Prochownick theory? An increase of proteins in these experiments has, according to Evvard, increased the size of the bones of the fœtus—the thing we wish to avoid if there is a contracted pelvis in the mother.

The subject of diet in pregnancy is complex, because we do not understand fully what effect the fœtus and its demands have upon the metabolism of the mother. Nor do we know the changes which occur in transferring the food into substances which may pass the placental barrier, but we do know that the same nutritive substances are found in the fœtal blood as are found in the maternal, and that the amount is about equal.

By animal experimentation we are able to study the various phases of metabolism in pregnancy, because of the shorter duration of pregnancy of animals, and because it is possible to keep an animal on a fixed diet throughout the entire period.

There is such a similarity of conditions between the human and the animal during pregnancy—for instance the dog has the same period of negative metabolism and vomiting is not infrequent—that valuable information may be gathered from the observation of animals. The question is often asked: Do animals, dogs, rabbits, rats, etc., require more food during pregnancy? No, they do not, although it would seem that they might, as the body weight of conception of the dogs is greater during pregnancy than that of the human. Such animals give birth to from 15 to 25 per cent of their body weight, while the human product of the weight of conception is but 8 per cent of the body weight.

Murlin quotes from the following experiments of Hagerman: "Hagerman found in the dog that pregnancy could be divided into two distinct metabolic periods. In the first half of pregnancy he found that the animal was in a negative state of metabolism with a diminution or a loss in the storing up of tissue building material. After this time, however, there was a gradual accumulation of nitrogen which was more marked as pregnancy advanced.

Jageroos' experiments upon dogs proved the same as those of Hagerman. He concluded that after compiling the nitrogen contents of the embryo and appendages, taking the time of pregnancy as a whole, it is to be regarded as a sacrifice on the part of the mother. And Van Ecke after his experiments upon rabbits came to the same conclusion.

From Bar's deductions from his experiments upon dogs and rabbits he divides pregnancy into two distinct periods corresponding to the two halves of pregnancy. He divides the periods thus—the first up to the third week. By that time there is a storage of nitrogen and a period of net equilibrium or even showing of negative balance, in the nutrition of the pregnant animal. This period is the second and continues up to the middle of pregnancy. From his whole series of observations he concludes that under proper hygienic and sanitary conditions a normal, healthy animal going through pregnancy will not suffer a sacrifice, but may actually increase her nitrogen capital. Wilson, too, agrees that the nitrogen stored is greatly in excess of the actual needs of the developing ovum, so much so that apart from the amount needed for hypertrophy and the development of the genitalia and breasts a large proportion of the nitrogen stored is added to the general maternal organism as rest material, although, concerning the form in which this reserve is stored we are unable to make any positive statement. The nitrogen capital of the maternal organism thus increased through the reserve supply may possibly be entirely exhausted during the puerperium and the period of lactation.

From these experiments upon animals we quote from Murlin's article the following:

1. Upon an adequate diet a dog, for example, may retain more than sufficient nitrogen to counterbalance, plus the quota taken up by the uterus and mammary glands.

2. Upon a diet which is only sufficient to maintain nitrogen equilibrium in the non-pregnant condition, due allowance being made for difference in weight, the pregnancy will result in a net loss. The catabolic effect of the presence of the fœtus is greater than the anabolic effect, taking the pregnancy as a whole.

3. While in the latter half of pregnancy there is generally a plus balance whatever diet there has been in the first half either an actual negative balance or a strong tendency thereto.

The amount of nutritive material necessary to sustain the fœtus for the first half of pregnancy amounts to so little that a mother could take that much in a single meal, and it would seem easy in such a length of time to store up this small amount, but physiologists tell us that the storing does not commence early. Catabolism has the upper hand and Gammell[1] has shown that it is not possible to overcome the tendency by heavier feeding."

E. P. Davis says: "The most important question in prenatal care is the effect upon the fœtus of the condition of the mother's nutrition. Does the well-fed mother produce the healthy child and does the ill-fed mother bring into the world the unhealthy and the unfit? Here one must remember that by the law of evolution the younger will live at the expense of the older if possible. The embryo or fœtus will nourish itself to the very last moment at the expense of the mother. The mother will suffer out of all proportion in disturbed nutrition to the condition of the child and hence from the standpoint of the child's interest the health and strength of the mother should be conserved in every possible way."

From reports of physiologists we must conclude that under normal conditions and a normal diet which has been normal for the woman in the non-pregnant state, the fœtus will grow, taking its nourishment from the mother's food and only selecting those substances in sufficient quantity for normal growth. And because of this selective process by the placenta a diet rich in carbohydrates and diminished in protein substance will in no way affect the fœtal growth.

Professor Buettner of Rostock has written the most logical paper on the diet in pregnancy I have read. He says: "The human has lost the property of instinct which was greatly developed in the animal. Due to this instinct the animal is able to select the food which is necessary to the welfare of the mother and the structural growth of the fœtus." I have tried to draw away from a literal translation of his article but may follow it pretty closely in the next few pages. The animal instinct in the selection of lime salt foods for the development of bone for the embryo is remarkable. Isolated examples of this instinct are shown in the human in those cases where the pregnant woman craves highly seasoned foods, sweets, or acids. These cravings seem justified and usually manifest themselves with great vigor, and are not so easily overcome as the appetite or cravings for this or that food often found in the non-pregnant. On this account, however, we cannot assume that the human through such cravings in every case is correctly guided by the instinct as is the animal. Now what are the food requirements during pregnancy? The nourishment must be of such a character that neither mother nor fœtus meets with loss in those elements which make for tissue building. For this purpose, is it necessary to take a greater quantity than one otherwise would? In general, no. For a baby born of a woman in the late stages of pulmonary tuberculosis is not of necessity a poorly nourished baby. Instead it is usually a well developed child. The tuberculous woman, in spite of the pregnancy, loses body weight. This quantitative reduction of nourishment in the mother is taken in the development of the fœtus.

The idea among the laity, that the pregnant woman needs more food than before pregnancy is true only if she is doing her work at the time. In the leisure class, or those women who cease bodily exertion from the moment of the beginning of pregnancy, it is better not to increase the quantity of food. If, however, the nourishment is increased for some reason, the patient must walk, which is, in the physical sense, work. We find the pregnant women who do not work eat more frequently and not so much at a time; this probably is not as harmful as if they ate not so often and a great deal at a time.

[1] Skandin. Arch., 1913, 28.

But does the quality of the food taken have any effect upon the development of the baby? Yes, it does. It must be the kind that best nourishes the human, for if there is a deficiency in the elements of the food necessary for body growth, the loss reacts upon the mother and child. For instance, to make my meaning clear, you may compare child life to plant life. If a plant needs for its development soil of certain ingredients it will not grow without them. If the soil has little of the special element the plant needs, the plant will live as long as that element hasn't been consumed by it—when the element is exhausted the plant fades and dies. So does the fœtus; it thrives just as long as the mother has anything stored for it to draw from.

For the mother's well-being, then, and not for the health of the fœtus, the diet must be rich in the elements of nutrition necessary for the best development of the human. For, to repeat, as long as the mother has anything stored, this parasite, the fœtus, takes what it needs, like an airplant that blooms on a half dead tree.

What are the principal elements of food? They are albumen, carbohydrates, fats, water, and salts.

Physiologists tell us that a woman of average body weight who does an average amount of work requires to maintain metabolic equilibrium for 24 hours, 100 grams of albumen, 80 to 100 grams of fat, 400 grams of carbohydrates. A diet which includes these elements must be mixed. Of the three principal elements of nutrition albumen is the most important. Of the salts the most important are lime, sodium, phosphorus, and salts of iron.

Let us for a moment consider diets. For instance: from 600 grams of beef fat (weighed raw) we get about 100 grams of albumen, and 150 grams of fat (50 more than needed). This gives the necessary amount of albumen and fat. Now, if to this we add bread and sugar we get the necessary carbohydrates. From the physiologists' deductions, this diet is sufficient for the non-pregnant woman. But it is not correct for the pregnant woman! It hasn't enough bone producing substance, and the fœtus would have to draw on the maternal organism.

Now take milk for a diet. From 3 litres of milk we get 100 grams of albumen, 100 grams of fat, and 140 grams of carbohydrates. To this add sugar and bread to finish out the required grams of carbohydrates. But on this diet the woman will lack iron and become anæmic even if she were to take on weight, which is quite probable. (Add to this diet meat and the maternal organism will maintain its equilibrium.)

Now we'll consider a vegetable diet. From 1 pound of peas we get 100 grams of albumen, but as the albumen of vegetables is not nearly so completely digested (a fact not generally known) as the albumen of meat, this is not sufficient albumen; it is about 30 grams short. As in the other diets for the carbohydrates we must add bread and sugar. However, we still lack sufficient salts and fats.

While all these diets are good, we can readily see that the diet must be mixed to get the principal elements of food, so that there will be no loss in the nourishment that makes for the best results in pregnancy.

Here I should like to emphasize the value of vegetables and of some fruits for their effect upon the intestines. The wood fiber of many vegetables, such as peas, beans, potatoes, etc., stimulates the intestines to regular function. Apples, raspberries, etc., are rich in wood fiber and stimulate the intestines as vegetables do.

And in connection with this diet we must speak of the fluids. That an increased quantity of fluid in the diet is necessary cannot be denied. The fœtus contains 60 per cent of water. This amount must be furnished directly by the mother, and the liquor amnion must be considered. If we give a non-pregnant woman a litre of water a day, she will, with normal metabolism, eliminate the same amount from the skin, the breath, and the urine. The pregnant woman, however, by the same intake, will retain a part of the fluid. She will hold a part back for the building up of the embryo, and for supplying her own tissues. In this way she increases the amount of blood and thins the body fluid. The body seems to need this thinning of the tissues, even though we can only theorize as to its reason. Therefore, the diet of the pregnant woman

under normal conditions should include more water than the diet of the non-pregnant woman. In pregnancy the taking of water at meals seems to have the same fattening effect as in the normal state. Therefore, it is better to take the largest amount of water between meals.

Now, granting that the mixed diet is the best for the wholesome and complete development of both mother and fœtus, the physician should suit the diet to each individual case, for, as it is in the non-pregnant woman so it is in the pregnant woman, that "what is one woman's meat is another's poison." Some women realize the truth of this old saying and ask the physician: "What shall I eat?" Oftentimes she is answered indifferently, and is so left in doubt that she selects her own diet or the diet that perhaps a friend of hers had followed. This is wrong, and the physician who neglects to find out the correct diet for his case is in grave error.

Also it is his business to find out her habits of living, her ability of assimilation of foods before pregnancy, her hereditary manifestations, etc. He would not select the same diet for a woman who spends her time sewing, playing cards, and such things, as for the woman who is athletic, and he would not select the same food for the robust as for the delicately constructed.

The best plan, then, is for the physician to find by observation what best suits each case, that is, the correct amount of air, exercise, rest, etc., plus the food that agrees with the patient. If he continues to watch the case so he may make a change if necessary, there will be little doubt about the outcome of the case in charge.

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CYSTADENOMYOMA OF FALLOPIAN TUBE

By Surgeon LUANG BORIBARN-WETCHAGIT and A. G. ELLIS, M.S., M.D., Bangkok, Siam
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CLINICAL NOTES

MRS. A.—, a Siamese woman of 23, gave the following history: Beginning at the age of 17 pain was felt in the left side of the pelvis for 2 days before each menstrual period and also during the period, ceasing when menstruation ceased. This continued until 3 months after marriage at the age of 21, when pregnancy began. During pregnancy and for 7 months after delivery of a normal male child, no symptoms were present. Pelvic pain then began during menstruation and soon became continuous and of increasing severity. Three months before admission to the hospital surgical advice was sought. A small tumor was demonstrable in the left side of the pelvis and as the menses had then ceased pregnancy was suspected. The constant pain became more severe, leading at times to convulsive seizures. A second examination showed that the tumor had increased in size and operation was advised. The patient came to the hospital November 2, 1919, and was operated on the following day.

An avoidal tumor, roughly described as the size of a hen's egg, was found in the left fallopian tube. It was situated 2 centimeters from the uterus and 1.3 centimeters from the ovary, and caused an almost symmetrical enlargement of the tube. Except for the presence of a few adhesions, the removal of the tumor was accomplished without difficulty. A longitudinal incision into the growth revealed a large central cavity, supposedly the dilated tube, which contained bloody fluid.

The patient made an uneventful recovery and left the hospital November 26, entirely free from pelvic pain.

PATHOLOGICAL NOTES

The specimen submitted for examination has been laid open longitudinally and hardened in formalin. The walls of the cavity are everted and shrunken, making present measurements only approximate. In this condition it is 6 by 4.5 centimeters. The outer surface is covered by serous membrane and is convex and smooth. The center is occupied by a cavity 3.5 centimeters long and 1.5 centimeters in diameter. The lining of this cavity is brownish-red in color and wrinkled, presumably due to shrinking in fixation. There are several small depressions in the wall of the cavity but no opening can be detected at either end or at any other point, as should be the case if this were the dilated fallopian tube, which it naturally was supposed to be. The wall of the cavity is quite uniformly about 1.5 centimeters thick and is of very firm tissue. No opening suggestive of a fallopian tube can be located in this part of the specimen.

Microscopically, the wall of the cavity is of smooth muscle and fibrous tissue, very largely the former. In most areas the fibrous tissue is only that in connection with the blood vessels which are fairly numerous, though at points it is mingled with the muscle. In some areas, especially toward the outer part, the vessels are quite large and the growth in general resembles in structure the musculature of the fallopian tube or is even more suggestive of a uterine wall. In other areas there are intertwining bundles of muscle as in myomata of the uterus.

The lining of the cavity is a single layer of columnar epithelial cells. These vary considerably in length, at places being very tall, at others of moderate height. The nuclei are basal. Cilia have not been detected. Below this epithelium is a cellular zone very similar to that of the intertubular portion of the endometrium. The cells are round or oval, the nuclei stain quite deeply, and there is a fair amount of intercellular material. This cellular zone is quite broad in some places, narrow in others. It gradually merges into the muscle of the growth, no structure resembling a submucosa being present.

In some of the sections are tube-like infoldings of the epithelial lining of the cavity. One of these is straight, one is an irregular space; the cellular zone beneath these tubules is very narrow. Transverse or diagonal sections of tubules are in the muscle some distance from the cavity. They are lined by columnar epithelium and are surrounded by a narrow cellular zone like that beneath the surface layer.

There is no evidence in any part of the sections of acute inflammatory processes, unless a few scattered polynuclear cells in the vicinity of one of the infolding tubules be regarded as such. Signs of chronic inflammation are entirely lacking.

Diagnosis: Cystadenomyoma of left fallopian tube.

As before stated, the diagnosis of the gross specimen was localized hæmatoma of the tube. Failure to find the lumen of the tube at either end of the cavity did not change this diagnosis as the localized dilatation would necessarily imply closure of the tube at each pole. The histological structure of the wall, however, seems definitely to exclude this supposition. Long standing distention of the tube by fluid might obliterate the folds of its mucosa but would not leave a lining of columnar epithelium, nor would it account for the cellular layer beneath it or the tubules in the muscle wall. It would also tend to thin the wall of

the tube instead of greatly thickening it. The conclusion seems warranted, therefore, that the specimen is a new-growth containing epithelial-lined spaces similar to those found in adenomyomata of the uterus and that one of these spaces became cystic because of hæmorrhage into it. Failure to find the lumen of the tube elsewhere in the growth may be because it had been obliterated by the latter, a reasonable supposition if, as the history suggests, it was of 6 years' duration. A lumen through the growth might also be overlooked because, owing to the nature of the growth being unsuspected, it was not sought until after the specimen was hardened in formalin.

The rarity of this type of growth of the fallopian tube is the reason for recording it. The argument between those who hold such masses to be inflammatory or specimens of salpingitis isthmica nodosa, and those who believe them to be mesonephric in origin, is an old one and need not here be reopened. In this specimen there is no evidence whatever of chronic inflammation. We believe this, together with the structure described, is sufficient to eliminate the inflammatory hypothesis in this case.

DEPARTMENT OF TECHNIQUE

FOOT-PIECE FOR THE THOMAS SPLINT

By C. W. MAXSON, M.D., Baltimore

THE objects of this addition to the Thomas splint are as follows: (1) It lends itself to a complete fixation in the Thomas splint and an absolute immobilization of the limb without the use of adhesive plaster or glues. (2) It is readily adjusted, quickly applied, and can be used without removing the shoe or boot. (3) It is portable and inexpensive. (4) It requires one trained only in first aid work to adjust the limb and make a comfortable transportation possible without the danger of secondary injuries of the soft parts of a fractured limb.

In the fall of 1917 while attached to the Royal Army Medical Corps, I was fortunate in having the opportunity of seeing and adjusting a large number of war injuries of the lower extremities. At that time I was impressed with the inadequate first aid dressings and limb fixations that were then being carried out by the allied armies on the western front. In September of that year, I devised the illustrated foot-piece and had the opportunity of using it continuously for seven months and of seeing it used by others with a universal satisfaction in a very large number of cases. Since returning to civil practice I have adopted the same method for temporary fixations and for transportation with equally as pleasing results. I, therefore, feel justified in presenting this addition to the profession for their consideration. Figure 1 shows the foot-piece in a front view. Figure 2 is a side view.

The appliance consists of a foot-board 12 inches by 4 inches, cut to conform with the natural angle of the foot. The heel-rest consists of a board 8 inches by 4 inches carved to agree with the normal contour of the ankle. These two pieces are joined at a right angle by angle-irons. The foot-board has a central runway to which is attached (by a thumb screw) a cross-arm of metal 10 inches long, 1 inch broad, one-sixteenth of an inch thick, notched at intervals of one-quarter of an inch to allow the piece to rest in the bars of the splint.

Figure 4 shows the foot adjusted to the foot-piece by a figure-of-eight bandage. Particular attention must be paid in those cases in which the shoe or boot has been removed, to a padding of the heel and foot-rest. If it is desirable to keep the limb in suspension for an indefinite period, a pad should be placed over the dorsum of the

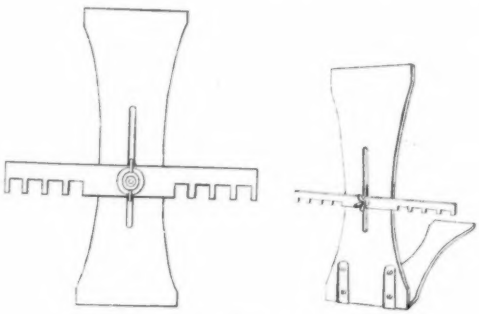

Fig. 1 (at left). Front view of foot-piece.
Fig. 2. Side view of foot-piece.

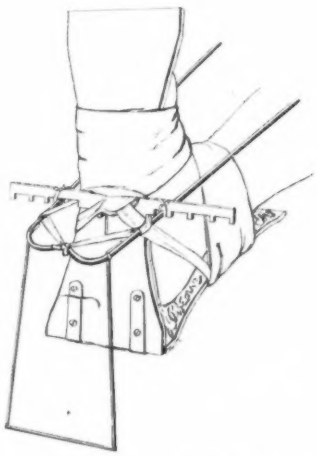

Fig. 3. Foot-piece and limb adjusted to Thomas splint.

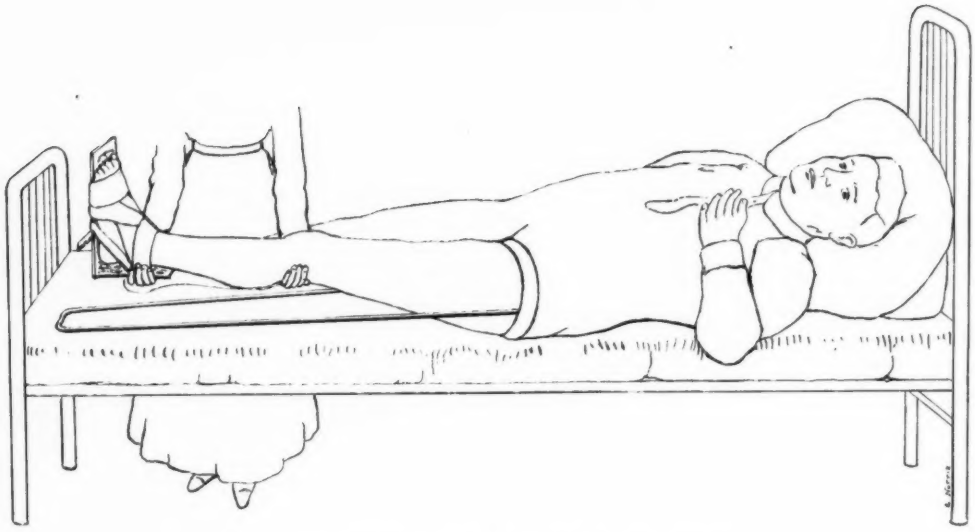

Fig. 4. Foot adjusted to foot-piece by figure-of-eight bandage.

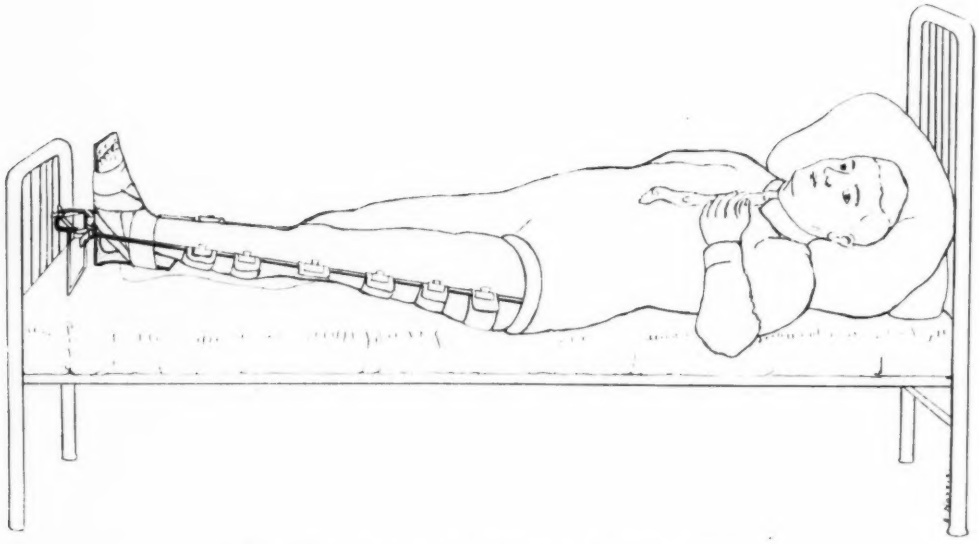

Fig. 5. Limb ready for transportation or temporary dressing.

foot. I have been using ordinary cotton batting approximately one-half inch thick for foot-piece and a depth of 3 inches for the heel-rest, an extra pad being placed just behind the ankle. The runway and set screw make it possible to adjust the foot in four positions: upward, downward, or rotate it inward or outward. A sufficient traction can be made by the means of a piece of bandage or stout cord looped around the cross-arm and attached to the end of a Thomas splint, producing the two desired results: (1) it drives the ring of the Thomas splint against the tuberosity of the ischium; and (2) it gives sufficient traction to give an approximate alignment of fragments.

Figure 3 shows foot-piece and the limb adjusted to the Thomas splint.

Particular attention must be paid to the comfort of the patient that the ring of the Thomas splint is actually resting against the tuberosity of the ischium and not pressing against the peritoneum.

In case an improperly fitting Thomas splint is being used, this difficulty can be overcome by a firm pad of cotton or wool placed on the outer side of the upper thigh forcing the outer bar and ring away from the body.

Figure 5 shows the limb ready for transportation or temporary dressing.

SUMMARY

As this method of dressing fractured and seriously injured limbs has proven itself to be worthy of consideration in the war zone, so it has proven its worth equally as good in civil practice and it is recommended in industrial plants, mines, and railway services where injuries of the lower extremities are numerous and transportation often desired, or where temporary fixation and traction is sought. When the physician does not desire to use either glues or adhesive straps on the injured limb, they will find in this method a satisfactory substitution.

A FURTHER NOTE ON THE ETIOLOGY OF RANULA

By ROBERT M. LEWIS, M.D., Baltimore

HAVING read with much interest in a recent number of Surgery, Gynecology, and Obstetrics an excellent article by P. G. Skillern, Jr., "A Contribution to the Surgical Pathology of Ranula," it seemed to me worth while to report a case very similar to his. The findings in my case were almost identical with Skillern's, and I am forced to agree with him in his conclusion that, as has been suggested by Fleischman and others, some ranulæ arise through disease of the sublingual bursa alone.

Both Skillern's patient and mine resorted to the surgeon for relief of a cystic tumor, which appeared in the floor of the mouth beneath the mucous membrane, as well as in the neck below the mandible.

Both patients had been operated upon before, the submaxillary and sublingual salivary glands of the side being removed to do away with the cyst, which in both instances recurred.

On operation in both cases, the cyst was found very thin walled in appearance "like a frog's belly." As did Skillern I found the cyst constricted at the point where it passed through the mylohyoid to the bursal area, beneath the mucous membrane of the floor of the mouth.

Microscopic examination of the cyst wall showed a very thin outer coat of fibrous tissue lined with a simple layer of flattened epithelial cells. Both cysts contained a glairy fluid which resembled the white of an egg and which could not possibly have been saliva.

Skillern treated his case by dissecting out the cyst in the neck, ligating at the point of constriction beneath the floor of the mouth and then opening the remaining locule through the floor of the mouth. He packed both cavities. In my case I dissected out the sac, previously injected with methylene blue solution, split the mylohyoid, cauterized with phenol and alcohol, and lastly packed without going through the mouth.

A brief summary of my case follows:

Patient H. B. Complaint, swelling in the floor of the mouth and beneath the left jaw. The patient has been operated upon four times elsewhere. The first operation was performed in 1908 for a cyst of the same side, but smaller than the present one. After each operation the cyst recurred. In January, 1919, the patient came to me with a cyst the size of a goose egg beneath the left jaw and in the floor of the left mouth. He refused to take a general anæsthetic. Not appreciating the difficulties that I would encounter I used novocaine. I exposed and unfortunately ruptured the very thin walled sac, removing as much of it as could be found along with the sublingual and submaxillary glands. The incision healed well. My patient returned just a year later with a recurrence. This time I insisted on his taking a general anæsthetic and was able to keep the cyst wall intact and trace it to the point where it emerged through the mylohyoid. This muscle I split, treating the upper locule as described above. The wound healed well. At present there is no evidence of recurrence of the cyst.

It seems to me that there can be no doubt but that this cyst originated in the sublingual bursa.

PROLAPSE OF THE FEMALE URETHRA

By THOMAS N. HEPBURN, M.D., F.A.C.S., Hartford, Connecticut

PROLAPSE of the female urethra may occur at any age, but seems to be more common in children than in adults. It is not very common even in children as Bruening (1), in 1911, could collect only 76 cases. In 1918, Roldan (2) reported another case in a child. Keefe (3) in the *Journal of the American Medical Association* discusses the subject somewhat fully and reports the condition in an adult, age 53, suggesting an operative procedure new to him, but in principle quite similar to that practiced by Kelly and Hunner at the Johns Hopkins Clinic.

Clinically, urethral prolapse may be described as coming on either gradually or suddenly. The prolapsed and everted urethra appears as a small bluish red tumor just anterior to the vaginal opening. A bloody serum exudes, so that the patient is forced to wear a napkin to protect the clothes. The chafing of the clothes or vulva causes the chief complaint. The prolapsed part may become so strangulated if allowed to persist that it will become gangrenous and slough away.

ETIOLOGY

Whether in adults or children, a marked relaxation of the muscles and tissues around the bladder outlet seems to be always noted. In women who have had children this relaxation may be explained by injuries resulting from labor, but in young children or nullipara it is probably due to congenitally poor structures which can not withstand the ordinary intra-abdominal pressures which occur with the strain of coughing or of constipation, or of heavy lifting. In other words its etiology is probably the same as that of hernia in other places, and the condition may best be looked upon as a partial hernia of the urethra and bladder resulting from strain on congenitally poor tissues.

TREATMENT

When the prolapse is moderate, local treatment with efforts directed to relieve unusual strain may suffice as in other slight hernia. When this fails some form of operative procedure is necessary.

If the condition occurs in adult women the favorite method of operation has been through the vagina. This method has been excellently described by Keefe, who also gives an illustration of Emmett's "button hole" operation. Keefe describes this procedure as consisting "in replacing the extruding membrane and shortening the constrictor muscle."

When the condition occurs in young girls it is obvious that the little vagina is so tiny that it presents no easy method of approach to the neck of the bladder. In these cases Kelley and Burnham advise a circular amputation of the protruding urethra. This does not appeal to me as the best procedure, as it does not prevent further prolapse. Therefore in children I wish to suggest the following operation, possibly also good for adults.

OPERATION

Fill the bladder. Make a suprapubic incision. Put a suture in the bladder so it can be used as a retractor. Work the fingers down in the prevesical space under the arch of the pubis. When the neck of the bladder and urethra are freed up enough, draw on the bladder traction suture. The prolapse will be seen to disappear as soon as this traction is made. Then with a curved needle and No. 2 chromic catgut anchor the neck of the bladder to the periosteum of the pubic arch. Be sure that retraction and anchoring is sufficient so that downward pressure with the hand on the full bladder does not produce any sign of prolapse. Drain prevesical space, if deemed necessary, for 24 hours.

I have recently done the above operation, which I have never before seen described, for prolapse in a girl 5 years of age. The whole procedure was very simple and easy, requiring only about 15 minutes and caused a negligible loss of blood. The little patient had slight pain, no dysuria. After primary union of the incision she was up in one week's time, with no signs of trouble.

I would suggest that special care be taken by the nurse to have the patient void frequently so as to keep the bladder relatively empty. In my case paroxysmal coughing, the result of enlarged tonsils and irritating adenoids seemed to be the immediate cause of the hernia. Such a condition should be remedied to avoid strain on the sutures before the traumatic adhesions are sufficiently formed to hold the bladder in place after the sutures are absorbed.

CONCLUSION

1. Prolapse of the female urethra is a true hernia, the result of strain and congenitally poor tissues.

2. The operation of choice for prolapse of the urethra in girls is through a suprapubic incision, by which route the prolapse can be reduced and the neck of the bladder anchored to pubic arch.

3. I see no reason why this simple operative procedure should not be equally applicable to prolapse in adults.

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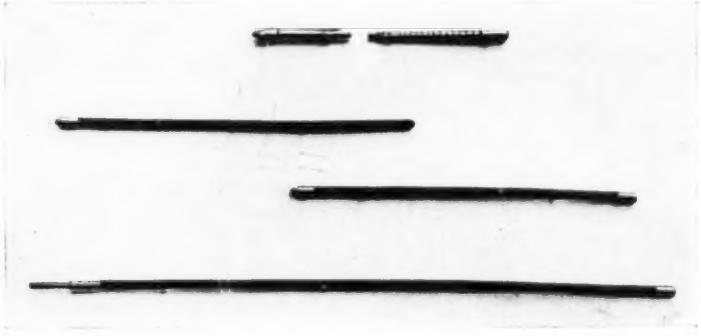
ŒSOPHAGEAL RADIUM APPLICATOR

By C. W. HANFORD, M.D., Chicago

THE application of radium to any part of the œsophagus is at best trying and difficult. The device shown in the photograph is the result of suggestions from James N. Neff. With this instrument radium can be applied to a carcinomatous œsophageal stricture with less trouble than has been our experience in using any other form of applicator.

The shaft of the instrument is of whalebone and is made in three sections so that it may be accommodated to any position in the canal. To the section of spiral wire, the silver tube containing the glass radium capsule is attached. The end of this tube is shaped like an olive. In the side of this olivary body is a small hole which connects with a narrow channel extending to the apex of the olivary body through which the string the patient has swallowed can be passed.



When ready to make the application the slack of the string in the œsophagus is taken up and the end threaded through the olivary body, and held. The operator passes the applicator down the œsophagus, and the string acts as a guide. It is best to give the patient a barium meal before application so that the passage of the applicator can be observed through the fluoroscope. When the radium tube is in position, the end of the whalebone at the mouth is passed through a hole in a metal mouth piece, which is strapped to the patient's head and fastened by a set screw. In the absence of the mouth piece, adhesive tapes may be used. In some cases, it may be desirable to substitute a shaft entirely of spiral spring for the whalebone.

It is Dr. Neff's practice to give the patient one-quarter grain morphine sulphate and 1/150 grain atropin; otherwise the operator is handicapped by the flow of mucus. A 5 per cent solution of cocaine is sprayed on the fauces to reduce gagging to a minimum.

IMITATION OF THE MECHANICAL PHENOMENA OF PARTURITION

New Obstetrical Machine

By Dr. JOSUÉ A. BERUTI, Buenos Aires, Argentine
Assistant Professor of Obstetrics, University of Buenos Aires

I AM going to discuss a subject, which although very old, is nevertheless of great interest to accoucheurs. I refer to the mechanism of parturition. There is not space for useless digressions. The surgeons of North America know very well the enormous amount of labor which such a study represents; they know also that, in spite of the time and ability expended in experimenting for more than a century, little of what is truly positive and satisfactory remains of innumerable hypotheses and interpretations, after a strict and impartial analysis of the question; for the explanation of internal rotation, or the most curious and surprising movement which the fœtus performs in the genital canal, is still a mystery. Yet, it would be pedantic and erroneous to dispense with much of the knowledge bequeathed to us by our eminent predecessors. The study of obstetrical mechanics must tend, in my modest opinion, to co-ordinate all that is good in the old with all that is good in modern teaching. This would permit us to abandon as fantastical and misleading so many false ideas of routine. It is, therefore, with an eclectic view that I venture to enter this rugged path. I will describe a machine which is made to imitate certain phases of the mechanism of the childbirth.

The use of instrumental demonstration of the mechanism of parturition must have its reservations; we must proceed on the basis that the deductions drawn from such experiments are of only a relative value, because, however perfect and exact may be an apparatus designed for imitating a function of the human organism, there will always exist a capital difference—the difference between the real phenomenon and the imitation, and at times the difference will be so great as scarcely to give even approximate results. In spite of this, and for many obvious reasons, instrumental demonstration has been sanctioned in physiology as a scientific method of great value; we do not see, therefore, why it should not be employed in the study of the physiological movements of the fœtus in parturition, with the understanding that for the correct interpretation of this mechanism, the combination of experiment with the observation of clinical facts is indispensable. I do not speak here of obstetric manikins, the inestimable value of which is recognized by all teachers, but refer to something more logical, to the reproduction, which is automatic to a certain extent, of the fœtal movements during labor.

The attempts made up to this date, e.g., by Inverardi in Italy and Candelón in Argentine, have been few and fruitless because of the difficulty of applying mechanical theory to the material reality of the experiment. In my opinion, the credit for having succeeded in obtaining with his machines a fairly exact reproduction of what was sought, belongs indisputably to Hugo Sellheim.

The apparatus which I present is very similar to that of Sellheim. It is based on certain ideas expressed in the laws of Gauss, Payot, Hubert, and Schatz, on the facts observed by Kaltenbach and Kehrer; and above all on the fundamental principles of Sellheim, which can be condensed as follows: "When a cylinder of unequal flexibilities is submitted to a twist or bending, the cylinder rotates about its longitudinal axis until the direction of maximum flexibility coincides with the direction of curvature." I will not venture to defend the doctrines referred to, but wish only to state that within their respective possibilities and limitations, all of them are related. The apparatus I have devised was inspired particularly by the teachings of Sellheim, but its construction, I consider entirely original, as anyone can see who will compare the two machines.

By some the laws of Sellheim may perhaps be considered erroneous or badly applied to obstetric mechanics. I respect such opinions, but I consider that with my apparatus, I bring a new argument to support the correctness of that interpretation. With this machine, I reproduce the automatic representation of internal or spiral rotation.

In a previous work[1] I described a first model, in miniature, of an obstetric machine. The second model, the diagrams of which are here reproduced, consists of a glass tube, which represents the genital canal, and of a wooden movable part, which represents the fœtus. As far as possible, these parts reproduce the anatomical and physiological conditions of the obstetric canal and of the fœtus. The tube, similar to the parturient

[1] Rev. Argentine de obst. y ginec., 1918, No. 6.

canal, is straight in its upper part and curved in its lower parts, its walls are of glass, and its cross section circular. The construction of the canal—the circular bore, and the rigidity of its walls—as far as the mechanics are concerned, is not unlike the findings in childbirth.

The movable fœtal part is represented by a spherical head connected with the trunk by a metallic spring, of unequal flexibility, which represents the neck. The trunk is composed of a cylinder arranged in such a manner that it is more flexible in certain directions than in others. Physically, it is the nearest approach to the living fœtus that it has been possible to make.

As to the forces of propulsion, I have selected hydraulic pressure, in order to copy as far as possible the natural condition of parturition, and in order that the progression of the fœtus may be effected in the slowest and most gradual manner possible.

Although the machine was conceived with the object of imitating the mechanism of parturition, the author does not claim to reproduce the mechanism absolutely; the apparatus does not demonstrate all details but shows the principles, although absolute dimensions are disregarded.

DESCRIPTION OF THE MACHINE

The apparatus is mounted on a platform *b* (Fig. 1) and can be kept in a wooden box *a*. It consists of three principal parts: a glass cylinder *o*, a receptacle *g*, and a movable part *j*.

The cylinder represents the pelvic genital canal. It is a circular tube, straight in its upper part and curved in the lower parts. It has an upper orifice *s*, which corresponds to the pelvic inlet, and a lower orifice *i*, which corresponds to the vulvar orifice. The latter is surrounded by a metallic ring *e*, provided with a small drainage tube, with the object of impeding the escape of the liquid introduced into the canal. The bend *c* of this canal corresponds to the perineal floor. The said cylinder is held by a horizontal metallic support *d*, which revolves about another vertical support *p*. An adjusting screw *l* permits the glass cylinder to be placed at any desired inclination.

The receptacle contains the water which will serve as the propulsive force of the movable fœtal part; it is provided with an insufflater *h*, which is employed to increase, if necessary, the hydraulic pressure. The receptacle *g*, communicates by means of a rubber tube *t*, with the genital passage, through a perforated rubber stopper *f*, which is adapted to the upper orifice of the said passage. According as the receptacle is raised or lowered the quantity of water introduced into the genital passage will increase or diminish, and at the same time the expulsive force, charged with driving the fœtus toward the vulvar orifice, will increase or diminish.

The movable part, j, represents the fœtus (Fig. 1). In Figure 2 the details of its construction are given. It is formed of the head *a*, the neck *b*, the trunk *c*, and the piston *d*. The head is a wooden sphere painted in two colors, with the object of permitting a better observation of the movements which it performs in the canal. The region *1*, painted black, corresponds to the face, that painted white, *2*, corresponds to the occiput. In this part of the head is a black line *3*, corresponding to the sagittal suture. The neck *b*, is shown in Figure 2, slightly deflexed, i.e., arched in the occipital direction; it represents an unequally flexible neck, with a greater flexibility backward toward the occiput than frontward or sideways. The trunk *c* is composed of two cylindrical pieces of wood, separated by a distance of several centimeters. The space between these cylinders is protected by a rubber casing, and is occupied by a system of springs which make this fœtal part more flexible in the direction of the shoulders *7* than in the anteroposterior one. The piston *d* consists of a rotatory metallic disc, in order to reduce resistance, covered with leather which, when moistened, gives a sufficient occlusion to prevent the escape of the water introduced into the canal.

In Figure 3 is a fœtal head with straight neck, of flexibility uniform in all directions.

EXPERIMENTS

First stage (Fig. 4). The movable fœtal part *j*, the neck of which is more flexible toward the occiput, is introduced into the pelvic genital passage in such a way that the head passes the pelvic inlet *s*, and remains flexed in left transverse position; i.e., with the white painted surface looking toward the spectator or reader, and its sagittal line remaining in the transverse diameter. The receiver *g* is connected with the glass tube, and everything is ready for applying the hydraulic pressure.

Second stage (Fig. 4). The expulsive forces are made to act by lifting the water receptacle. It is then observed that the movable fœtal object, impelled by hydraulic pressure *p.h.* traverses the straight portion of the canal without undergoing any rotation; but when the head arrives at the angle *c* of the latter, it begins to rotate in the anterior direction about the longitudinal axis of the movable object, i.e., from left to right. In

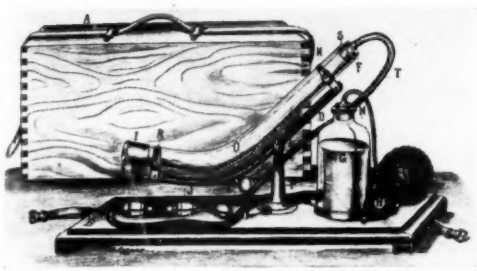


Fig. 1. Obstetric machine. *a*, wooden box; *b*, platform; *o*, glass cylinder (pelvigenital canal); *s*, pelvic inlet (superior straight); *c*, bend of canal; *i*, vulvar orifice, *e*, metallic ring with drainage tube; *p*, vertical support *ii* horizontal support *l*, adjusting screw; *g*, receptacle; *h*, insufflator; *t*, rubber tube; *f*, perforated rubber stopper; *j*, movable part (fœtus); *k*, another fœtal head.

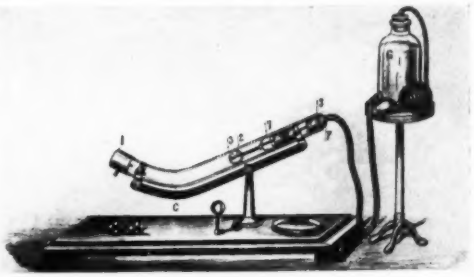


Fig. 4. First stage. The movable fœtal part, the neck of which is more flexible toward the occiput, is introduced into the pelvigenital passage (pelvic inlet, *s*) and remains flexed in left transverse position. The receiver *g*, is connected with the glass tube and everything is ready for applying, by hydraulic action, a movement of translation to the fœtus. *2*, occiput; *3*, sagittal suture; *7*, direction of shoulders.

Figure 5 it is seen that the sagittal line of the head is no longer in the transverse direction, but has arranged itself in an oblique diameter, in such a way that the lesser fontanelle is now situated in the left anterior iliac position. The line of the shoulders *7* still has not suffered any forward rotary movement, because they have not yet arrived at the bend of the canal.

Third stage (*Fig. 6*). The fœtal head, in its progress toward the vulvar orifice has terminated its internal rotation, it has described an arc of 90°, and its sagittal line has consequently arranged itself in the anteroposterior diameter of the canal; for this reason the sagittal line is not seen in Figure 6. The trunk begins to rotate, the shoulders taking up their position in the oblique left diameter.

Fourth stage (*Fig. 7*). The internal rotation of the trunk has terminated; the line of the shoulders has also described an arc of 90° and has

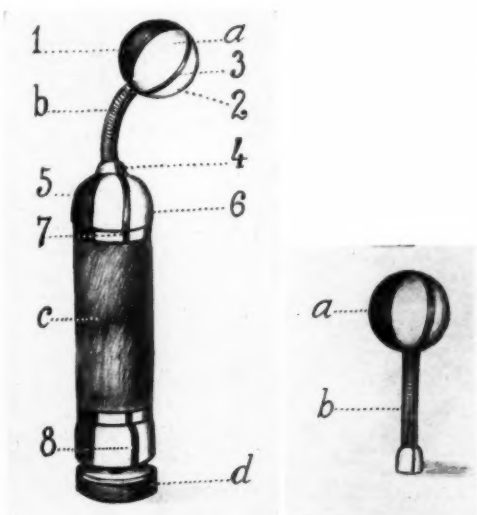


Fig. 2 (at left). Movable part. *a*, head; *b*, neck, *c*, trunk; *d*, piston, *1*, facial region, *2*, occipital region; *3*, line corresponding to the sagittal suture; *7*, direction of shoulders (bis-acromial direction); *8*, bis-trochanteric direction.

Fig. 3. Fœtal head with straight neck having uniform flexibility in all directions. *a*, head; *b*, neck.

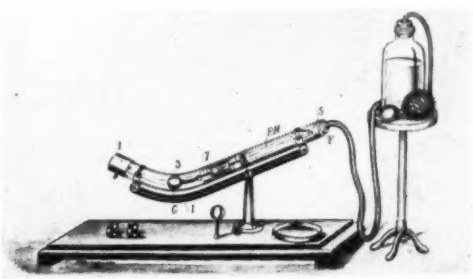


Fig. 5. Second stage. The movable fœtal object, impelled by hydraulic pressure, traverses the straight portion of the canal without undergoing any rotation, but when the head arrives at the angle *c* of the latter, it begins to rotate in the anterior direction: left occipito-anterior position. The sagittal line, *3*, is no longer in the transverse direction but has arranged itself in an oblique diameter. The line of the shoulders *7* still has not suffered any forward rotary movement, because they have not yet arrived at the bend *c* of the canal.

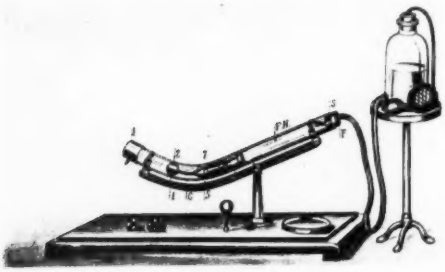


Fig. 6. Third stage. The fœtal head, in its progress toward the vulvar orifice, has terminated its internal rotation and the sagittal line has consequently arranged itself in the anteroposterior diameter of the canal. The trunk begins to rotate, the line of the shoulders, 7, taking up their position in the oblique diameter.

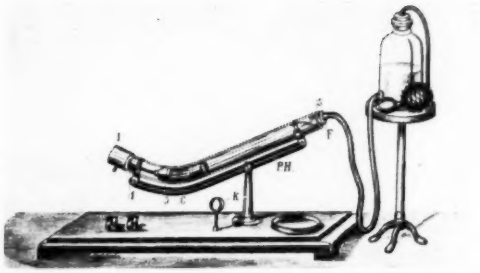


Fig. 7. Fourth stage. The internal rotation of the trunk has terminated; the line of the shoulders has also arranged itself in the anteroposterior diameter.

arranged itself in the anteroposterior diameter. For that reason, the said line is no longer visible in Figure 7.

Fifth stage (*Fig. 8*). The head has now emerged; a tendency to deflexion is still to be noticed. At this time the trunk commences to emerge.

Sixth stage (*Fig. 9*). The fœtus has been expelled. The experiment being completed, we proceed to collect the liquid in the same receptacle *g* lowering the latter and inverting the canal. The machine thus remains ready for a new experiment.

Another experiment would consist, for example, in placing the fœtal head in left transverse position. By means of this apparatus the internal rotation toward the front would be equally precisely verified. It is unnecessary to add the numerous possible variations of the two preceding experiments which might be demonstrated.

COUNTER PROOFS

With the same machine, various counter proof experiments can be effected. One of them consists in causing the movable fœtus *j*, Figs. 1 and 2, to glide through a straight channel; neither the head nor the trunk rotates toward the front, through absence of one of the factors indispensable for the rotation of the movable fœtus: the curvature of the obstetrical canal.

The other counter proof is demonstrated by causing to pass through the curved glass tube a movable fœtus, *k*, whose neck, as in Figure 3, possesses a flexibility uniform in all directions. Figure 10 will explain the experiment. Here, contrary to what happens in the previous experiment, the curvature of the canal exists, but there is wanting the unequal flexibility of the fœtal neck, a factor which is also indispensable for spiral rotation of the head. The trunk, on the other hand, rotates as in the first experiment, because we had intentionally given it a flexibility greater toward the shoulder line.

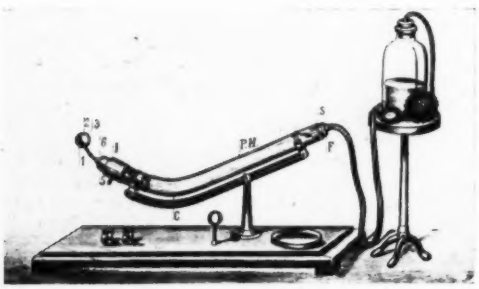


Fig. 8. Fifth stage. The head has now emerged and the trunk commences to emerge.

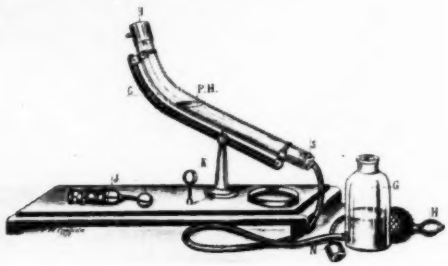


Fig. 9. Sixth stage. The fœtus has been expelled. The experiment being completed, we proceed to collect the liquid in the same receptacle *g* lowering the latter and inverting the canal. The machine thus remains ready for a new experiment.

CONCLUSIONS

In summarizing I would say that I believe that the machine which I have described is useful for various reasons:

1. It confirms a law of pure physics.
2. It is a new proof of the exactitude of certain recent knowledge in obstetrical physiology.
3. It strengthens the interpretation which Sellheim gives to the mechanical phenomena of parturition.
4. It permits, from the educational point of view, a clear and automatic demonstration of the fundamental movements of rotation and translation which the fœtus effects in its transit through the birth canal, because by means of the apparatus can be observed the descent of the fœtus, the internal or spiral rotation of the head and the cephalic extension, and the internal rotation of the shoulder.

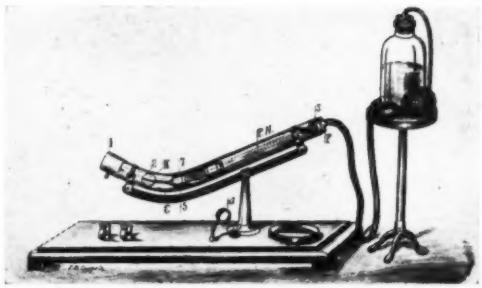


Fig. 10. A counter proof: a movable fœtal object, *k*, the neck of which, as in Figure 3, possesses uniform flexibility in all directions is passed through the curved glass tube. Here, the curvature of canal exists, but there is wanting the unequal flexibility of the fœtal neck. The head does not rotate. The trunk on the other hand, rotates as in the first experiment, because we had intentionally given it a greater flexibility toward the shoulder line.

A TABLE FOR MANIKIN DEMONSTRATIONS

By HENRY W. ANTZ, New Haven, Connecticut
From the Department of Obstetrics and Gynecology, Yale Medical School

ANY one who takes part in the course generally given with the assistance of the obstetrical manikin is familiar with the difficulties encountered. A convenient table must be specially constructed. Whenever a demonstration is given the articles required must be assembled and, in the meantime, as they are not objects which may be left exposed even in a laboratory they must be stored under cover. Moreover, the nature of the demonstrations is such that considerable care must be exercised, otherwise the articles used and the room in which the demonstrations are given become filthy. To overcome some of these difficulties, we have devised a table which is used as a support for the manikin at the time of demonstration, as a repository for the various objects required in this type of instruction, and as a laboratory fixture when it is not being employed for class-work.

The table shown in the accompanying illustrations is mounted on rollers which may be locked at the time demonstrations are given. It is 30 inches high and the top measures 44 by 30 inches. In general, the table consists of three parts. At

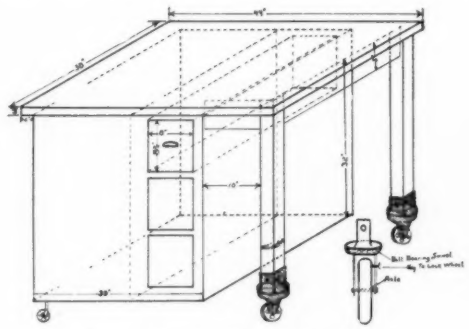


Fig. 1. Construction details of table.

Fig. 2 (at left). Showing compartments in the table.
Fig. 3. Showing table as a laboratory fixture.

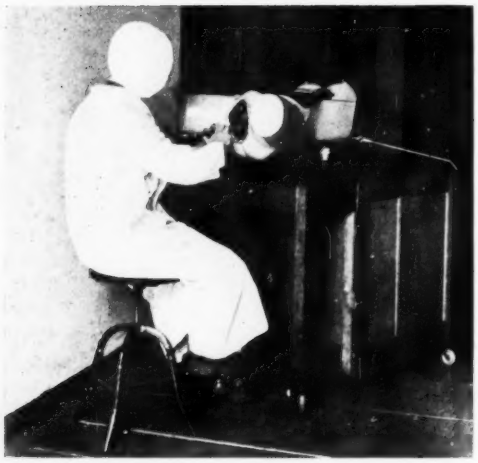


Fig. 4. Showing table in use for forceps operation.

one end there is a cabinet to accommodate the phantom and this compartment measures 26 by 29 by 15.5 inches. At the opposite end, an arrangement is made to give space beneath the table so that one may be seated more comfortably for the performance of operations upon the manikin. In the middle of the table are three drawers, one above the other, each of which measures 23.5 by 8.5 by 8 inches. In these drawers the various articles required for manikin demonstration are kept: in the upper drawer the embalmed fœtus in a suitable container; in the middle drawer the obstetrical forceps, a leather manikin, jars of vaseline, and other articles used in connection with manikin demonstrations; in the lower drawer a supply of towels and soap.

The height of the table is such that, when the phantom is in position, abdominal palpation may be conveniently performed by the student standing at its side. Likewise, the position of the phantom is correct for the performonce of various obstetrical operations provided the student is seated upon a stool 24 inches high.

When a manikin demonstration is completed the various objects used are returned to their place in the table which is then wheeled out of the class-room into the laboratory where it serves the purpose of a table. With care this piece of furniture is kept clean and the real purpose it serves is not suspected by the casual observer.

INTESTINAL OBSTRUCTION FOLLOWING THE WEBSTER-BALDY OPERATION FOR RETROVERSION

Report of a Case

By EDWARD P. RICHARDSON, M.D., F.A.C.S., Boston

THE Webster-Baldy operation for retroversion, although having the disadvantage of being effective only in a limited class of cases needing careful selection, as shown by Polak (1), has on the other hand the advantage of avoiding the formation of pockets or ligamentous bands which might serve as a cause for intestinal obstruction. I had felt that the operation *per se* was free from the possibility of intestinal obstruction except in so far as any laparotomy may be to a greater or less extent the possible cause of obstruction through the formation of peritoneal adhesions. On this account the following case in which intestinal obstruction was directly due to the Webster-Baldy operation as performed, has been of interest to me. I have been unable to find a similar case in the literature.

Mrs. E. H., age 42, was admitted January 3, 1918, to the Henry Heywood Memorial Hospital, Gardner, Massachusetts, with the following history, for which I am indebted to the Hospital. Two years ago the patient was operated on in Worcester, Massachusetts. The hospital at which the operation was done reports that she had an appendectomy, a suspension of the uterus, and a repair of the perineum performed. The diagnosis of Glenard's disease was also made.

January 1, 1918, while waiting for a car, she was seized with severe pain in the pit of the stomach. She was nauseated and vomited during the night. The pain persisted, and a steadily increasing distention was noted. On January 2, she was given one and a half ounces of castor oil and an enema, without a movement. The bowels moved on the morning of January 1, but had not moved since. The periods had been irregular, the last a week ago.

Examination showed a well-developed woman with a somewhat cachectic appearance and a slight yellowing of the conjunctiva. Tongue slightly tremulous, with a white coat. Pupils react normally. Heart and lungs negative. The abdomen was distended and tympanitic, and the outline of portions of the intestines could be seen through the abdominal wall. Tenderness on pressure was not localized clearly, but seemed to be most marked in the lower part of the abdomen and flanks. No masses felt. No spasm. Vaginal examination negative. No œdema. Knee jerks present.

Operation, with the assistance of A. P. Lachance, January 4, 1918. Ether. On median suprapubic incision, I found the small intestine greatly distended. The point of obstruction was located in the region of the right broad ligament. On further exposure the following condition was found: Retroversion of the uterus had recurred. On the right side, a loop of small intestine, three or four inches in length, had prolapsed through a perforation in the right broad ligament. The round ligaments on both sides passed through the broad ligaments to a point of abnormal attachment on the posterior surface of the uterus. The perforation of the right broad ligament was external to the right round ligament which passed through the opening. The loop of the intestine which had herniated through was deeply congested but viable. There was no open perforation in the left broad ligament, and the pelvis was free from adhesions. The constricted loop of the intestine was freed by the removal of the right tube and ovary, which seemed simpler and more direct than attempting reduction and closure of the perforation. The uterus was fixed to the abdominal wall, and the wound closed. The patient made a good recovery, and was discharged January 22, 1918.

The interesting point in this case is how such an open perforation in the broad ligament happened to persist. Ordinarily the round ligaments when drawn through the broad ligaments, fill the opening snugly, and the persistence of an opening through the broad ligament, even in the absence of sutures approximating the broad to the round ligaments, seems extremely improbable. I believe, in this case, the round ligament on the right side was drawn through the broad ligament, which may have been thin, too far away from the body of the uterus, and possibly through too large an opening. Any strain on the round ligament would then tend to make it cut through

Findings in author's case.

the broad ligament toward the body of the uterus and the median line. This tendency would be increased by a recurrence of the retroversion. In this way an open perforation of considerable size through the broad ligament might persist. Given the perforation, and a recurrence of the retroversion, which tended to make of the broad ligament a shelf-like partial diaphragm, more or less perpendicular to the axis of the pelvis, it is easy to see how a loop of the intestine dropped through.

In connection with this case, it is well to note that Webster (2), in his original article, specifically mentions suture of the broad and round ligaments at the point of penetration. The above case shows that it is not always safe to omit this step in the technique.

REFERENCES

1. J. Am. M. Ass., 1913, lxi, 1430.
2. J. Am. M. Ass., 1901, xxxvii, 913.

TRANSACTIONS OF SOCIETIES

JOINT MEETING OF THE CHICAGO MEDICAL AND CHICAGO SURGICAL SOCIETIES

HELD JANUARY 21, 1920, DR. CHARLES E. KHALKE, PRESIDENT, CHICAGO SURGICAL SOCIETY, PRESIDING

SOME PRINCIPLES INVOLVED IN THE TREATMENT OF EMPYEMA

DR. EVARTS GRAHAM, St. Louis, Missouri, read a paper on the treatment of empyema. (See p. 60).

DISCUSSION

DR. WALTER W. HAMBURGER: Dr. Graham's conclusions as to the value of delayed operations were reached in various camps throughout the country in general, and his clean cut experiments on dogs give a definite basis for his conclusions. Our experience at Camp Taylor approached probably in many ways the general experience throughout the country, and this experience I may recite briefly.

In the early fall of 1917 the cases of pneumonia were comparatively benign, with a mortality of only 2 or 3 per cent. About the first of December an acute measles epidemic struck the camp, and about the middle of December we had post-measles bronchopneumonia. Along about the 20th an epidemic of post-measles developed and from the middle of January we had a large number of cases of empyema. Our first empyemas, as I recall, were found at autopsy. They were overlooked in the clinical wards. From that experience we X-rayed and tapped almost every case of bronchopneumonia for the first two or three weeks, in order to be certain not to overlook other post-measles empyemas. As soon as the diagnosis by X-ray or tapping was made, the cases were operated on, and toward the early part of January the mortality kept increasing. About the 10th of January, in spite of early diagnosis and early operation, in conference with the surgical side and the laboratory side, we decided we could not do worse than what we were doing by operating as early as possible, and so we decided to withhold operation. From the 10th of January on these patients were X-rayed daily and tapped as often as necessary, but we withheld surgical interference as long as possible. Our mortality promptly dropped from 30, 35, to 40 per cent, and toward the end of January the percentage was around 10 to 12. Delayed operation seemed to be beneficial to the empyema cases. However, in March, 1918, a second measles epidemic was ushered in, followed by a second measles empyema epidemic. In spite of our improved methods of treatment in withholding operation, our mortality began to rise very high. I think this point is of considerable importance, and one which I am sure Dr. Graham will agree upon but did not mention; that is, the importance of the virulent infecting organism. The virulence of the infecting organism in all infectious empyemas should be considered in appraising the value of any surgical procedure.

In March, although we had the experience of the earlier measles empyema epidemic, of withholding operation, our mortality again rose to a high point. As a result, the general conclusions reached in the spring and summer of 1918 about the general empyema problem, as we saw it at Camp Taylor, were these: The conception we had and still have is that empyema of this type is an acute infectious pleuritis, often primary without any pneumonia whatever. It is often the part of a general sepsis with streptococci in the blood stream, in the heart's blood at autopsy, and in blood cultures during life, with streptococci in the meninges, in the pericardial fluid, and pleural fluid. This primary pleuritis or streptococcic sepsis may first set up a streptococcic pneumonia of the interstitial type, and with this secondary pleuritis we may have also a primary pleuritis. The first stage of primary pleuritis or primary streptococcic sepsis is ushered in in the individual patient by a temperature of 103 or 103.5°, with agonizing pleural pain, with a leucocyte count not very high, from 12,000 to 15,000, and respiration from 36 to 40. In the early days this picture was taken for lobar pneumonia and was so diagnosed; but as cases died within 24 or 48 hours it showed that the cases were not suffering from pneumonia. The lung tissue was not consolidated; the pleura showed pleuritis with empyema. As this process progressed, if the patient survived the original onslaught of the severe infection, he passed into the second stage, during which the patient was much better; his temperature was 102 or 102.5°; his pulse became slower; respiration slower; and the leucocytes increased. Tapping of the pleural fluid showed a serous or seropurulent effusion. In the first stage we found a creamy, thick pus, on paracentesis; the leucocytes gradually rising, respiration, pulse, and

temperature dropping. During the third stage surgery gave the best results. The progress of the disease was divided into these three stages, after reviewing the histories of all empyema patients, and the data collected in reference to the leucocyte count, the pulse and the temperature. The cases grouped themselves very nicely into these three stages. There was no definite time relationship between the three stages.

The best treatment for acute infectious empyema during the first and second stages, with the demonstration of a thick, creamy pus, is waiting medical treatment, supportive treatment, but no actual surgical intervention. The leucocyte count and pulse rate are the best guides, the leucocyte count rising gradually as the process matures; the pulse rate dropping gradually. But if the pulse rate after it has dropped begins to rise, the leucocyte count staying high, we promptly refer such cases to the surgical service.

There is one other point which may interest some of you. During the summer when most of us were making preparation to study and read French, I came across the second volume of Larrey's *Memoirs*. You doubtless remember that Larrey was Napoleon's chief surgeon, and the inventor of the flying ambulance. In this second volume there is a chapter on empyema, in which he says: "I have never been able to ascertain why the operation for empyema, when performed to evacuate sanguineous or purulent collections in the thorax has been so unsuccessful. The cases which occurred in the hospital of the guard during the years 1810, 1811, led me to inquire into the causes of this failure, and to make myself acquainted with the resources which nature adopts in cases where a recovery has followed the operation."

Larrey cites several cases where acute infectious empyema in the French Armies occurred at that period. It is interesting from the fact of our own experience in this war and the occurrence of acute infectious empyema, with a high mortality, so that it is an old story so far as military medicine is concerned. Napoleon's men were seized with the same sort of epidemic as our men and they had the same difficulties to contend with in regard to treatment.

Dr. Ernest E. Irons: Medical records apparently indicate that the same type of empyema was met with in the War of 1812, and in the Civil War, as was encountered in 1917 and 1918.

Dr. Graham has thoroughly covered the main points in the treatment of empyema. He has demonstrated the importance of bearing in mind the physiology and the anatomy of the mediastinum, and he has referred to the very great importance in the matters of prognosis and treatment of the type of organism which is the cause of the empyema.

In the old type of pneumococcic empyema, patients recovered relatively frequently; the type which we saw in 1917 and 1918 was such that more patients died than lived during certain portions of the epidemic. I am inclined to think that, while we grant the great importance of the work outlined by Dr. Graham and the necessity of delay in open operations, surgeons are a little inclined to accept more responsibility for the deaths in the period 1917–18 than they can rightly be charged with, because the mortality of patients untreated was also high. Many of the patients died without empyema being discovered. They were highly septic. In one camp with which I am quite familiar we had the same experience outlined by Dr. Hamburger, and having decided that surgical treatment by open operation of empyema was about as unsatisfactory as it could be, it was stopped, and the next series of patients were treated by the expectant plan with no better results. In all of these cases there was a severe sepsis.

Comparing statistics collected at different times is somewhat dangerous because, as was indicated by Dr. Hamburger, the severity of the disease varied from time to time. This was particularly true in the winter of 1917 and 1918, and in the spring of 1918, and again in the fall, so that the mortality unmodified by operation varied very greatly. We may quote statistics of 40 per cent mortality in the winter, 20 per cent in the spring, and only 6 or 7 per cent mortality of treated empyema during the epidemic of influenza.

During the epidemic, in the fall of 1918, in one region the prevailing organism was the Pfeiffer bacillus; in another region the streptococcus, and in another, but to a more limited extent, the staphylococcus. With each of these organisms, the incidence and severity of empyema differed. This fact is important when one compares a series of statistics obtained in any one locality with those obtained in another.

Dr. Joseph L. Miller: I wish to emphasize the points brought out by Dr. Hamburger and Dr. Irons. First, I wish to refer to the statement made by Dr. Graham which is important, that in the future, when we talk about empyema or the statistics of empyema we must discuss them in terms of bacteriology. Streptococcus empyema is different from pneumococcus empyema, and this epidemic which occurred in the various camps was entirely different from any epidemic which I think anybody present in those camps had ever seen. Empyema was a complication in 30 to 35 per cent of the cases. In other words, one patient in three would have empyema which developed very early in the pneumonia. As the epidemic progressed, the virulence of the infection gradually lessened. One could see readily in going through the wards from day to day that as the epidemic progressed the disease became much milder.

Early in the epidemic everybody drained cases of empyema, which was then considered the best method of treatment, although from 50 to 90 per cent of these patients died. When you examined these patients at autopsy you found why they died, not as a result of the operation *per se*, but they died

because they had streptococcic septicæmia. Twenty-four per cent of the cases coming to autopsy had peritonitis; exactly the same percentage had suppurative pericarditis. Furthermore there were multiple small pus collections, especially in the interlobar spaces. This group of cases died no matter what was done for them. I have no doubt surgeons hastened the death of these patients, but they would have died, no matter what was done. Later aspiration was practiced and we found the results were better. I do not believe the results were better because we practiced aspiration, but better because the virulency of the disease was less. Peritonitis, pericarditis, became much less frequent. We found the pus was more localized. In support of that in our first 49 cases of empyema we drained with a mortality of 52 per cent. The next 42 cases were aspirated and drained, with a mortality of 32 per cent. We had 40 cases following this with immediate drainage with a mortality of 28 per cent, with exactly the same method of treatment at different times of the epidemic. The mortality in one instance was 52 per cent, only 28 per cent in the other.

It is my opinion that if we should go through an epidemic of this sort again, with our present knowledge of treatment, we will have practically the same mortality as we had in that epidemic. Our improved methods of treatment, while valuable in treating pneumococcus empyema, will not modify or very slightly the mortality in an epidemic of the sort we had then. In making autopsies on these patients, no matter what operation was done, we found pus was left in that could not be reached or found, and it is this that killed these patients. They died because they were very toxic. It was not the empyema that killed them or operation, but their extremely toxic condition. Operation, in all probability, hastened their death.

I think there is one point we should emphasize in our observations on the treatment of empyema, as based on this particular epidemic, and that is, there may be danger in promulgating too widely the idea that operation should be delayed in cases of empyema and aspiration practiced first. That depends entirely upon the condition of the patient. In the ordinary pneumococcus pneumonia where empyema appears after the acute pneumonia has subsided, the sooner we get the pus out the better. If empyema develops early, where the patient is intensely toxic, if we can aspirate once or twice until the patient recovers from the empyema, it will be desirable.

DR. GRAHAM (closing the discussion): I have just a word or two to say in closing the discussion on my paper. I fear I did not make myself clear when I said that I felt it is desirable to avoid open pneumothorax in these early cases. I did not mean necessarily it was desirable to avoid early operation. It is possible to institute drainage early in these cases if we desire to do so without creating an open pneumothorax. Dr. McKenna has devised a satisfactory method for instituting such drainage, and I am sorry he did not say something about it.

Neither did I mean to imply that we ought not to take measures to relieve the patient of dyspnœa, as much as we can, by removing the fluid exudate which has accumulated. The main point, however, which I did wish to bring out in regard to this was that if we operate and create an open pneumothorax during the stage in which the exudate is serofibrinous, we enter the free pleural cavity at a time when the patient is least able to stand it. His vital capacity is very low. If we wait before creating an open pneumothorax until the serous or serofibrinous fluid is frank pus, we do not enter the free pleural cavity, but instead we enter a circumscribed abscess and do not create an open pneumothorax. Furthermore, if we withhold operation until after the pneumonia has subsided, the exudate will have been removed from the bronchioles so that there is less impediment to the passage of air down into the alveoli, the vital capacity will have been increased, and the patient will be in a much better condition to withstand an open pneumothorax. In other words, the resolution of the active pneumonia is analogous to loosening a string from around the trachea. That the establishment of an open pneumothorax is an important matter in these early cases can be demonstrated, not merely by statistics which possibly are open to question, but also by direct experimentation. In fact, we feel we have demonstrated this, to our own satisfaction at least, on dogs. If you produce experimental empyema in dogs with a hæmolytic streptococcus culture and establish open drainage in one series, and do nothing to the other series, you will find that the dogs in which you have instituted early open drainage will die in a much larger percentage of cases than those dogs in which you did nothing at all. It is only fair to draw conclusions from cases in which you are dealing with the same strain of organism. But you can inject dogs with the same strain of organism; you therefore know you are dealing with an organism of identical virulence in every case. Furthermore, you can give accurate dosages, so that you know that you are giving each dog the same quantity of bacteria and of the same virulence. The only variable quantity is that one of the series is an open pneumothorax, and the other is not. We found, for instance, when we produced experimental empyema in 20 dogs by injections of the same strain of hæmolytic streptococcus and created open drainage in 10 of the dogs within 24 hours that 9 of the dogs died. The only dog of this series which survived pulled the tube out within a few hours after the operation and got a closed pneumothorax instead of an open one. Of the 10 other dogs to which nothing had been done, only 7 died, and 1 of the 7 died as a result of a fight on the fourth day and at autopsy had no evidence of empyema. It was a comparison therefore really of 90 and 60 per cent in the two series, but it was done under strictly comparable conditions.

Our experiments on pneumothorax also explain very nicely the findings of Duval, Gask, and others,

to whose work Dr Muller and Dr. Yates have both alluded, that it is possible to make openings in the chest wall of a surprising size without the death of the patient from asphyxia. It is easy to understand from these experiments that a normal human being, even without induration of the mediastinum or without adhesions, can compensate for a large opening in the thoracic cavity. It is possible to demonstrate with a fair degree of accuracy by a mathematical expression what the maximum opening can be. In the average adult, comparing women and men, the maximum non-fatal opening of the chest wall is approximately 8 square inches (about 50 square centimeters). On the other hand, in certain individuals, with high vital capacities, this size may be increased to one of about fifteen square inches (101 square centimeters). In general, men will be able to compensate for larger openings than women because they have larger vital capacities. Conditions which tend to reduce the vital capacity will also reduce the size of the maximum non-fatal opening in the chest wall. It is, therefore, not surprising that large thoracotomy wounds can be made without death from asphyxia in the normal individual.

Dr. George P. Muller, of Philadelphia, discussed "Traumatic Injuries of the Chest in Civil Practice."

CHICAGO GYNECOLOGICAL SOCIETY

Regular Meeting Held February 20, 1920, Dr. Arthur H. Curtis, Presiding

DIET IN PREGNANCY

Dr. Charles E. Paddock read a paper on diet in pregnancy. (See p. 71.)

DISCUSSION

Dr. Charles S. Bacon: There are many sides to the subject, and I would like to touch on one or two phases. The first thing I would note is that the essayist did not speak of diet in pathological conditions. I think we have to take that into consideration because pathological conditions are so intimately connected or attended with so much difficulty that it is not easy to differentiate them from normal conditions. So we have to consider such things as indigestion and kidney complications, particularly in discussing the diet of pregnancy. The most common complication we have is more or less indigestion, often heart-burn, and so on. The diet should be modified in these conditions. I have found quite frequently that the excessive consumption of sugar in some form or other is responsible for considerable indigestion. Also fats may be indigestible with some patients, and to this point the essayist has called our attention. There is a difference in patients in that respect, and I would emphasize the preparation of food as an important element. The diet in kidney complications undoubtedly has to be modified, and I take it from what Dr. Paddock has said that he would agree with the commonly accepted opinion that proteins must be used with restriction in the cases of the kidney of pregnancy and its complications.

He called attention forcibly and very correctly to the importance of some of the mineral elements of the food, but he failed to call attention to the accessory elements of food, in the vitamins. This is of particular interest because of the suggestion that has been made that possibly a deficiency in the vitamin element of the food is responsible to a certain extent for cases of hyperemesis gravidarum. Certainly, the symptoms produced by diet, where some of these accessory elements are lacking, neuritis and so on, are more or less common in cases of hyperemesis, and that is one point in the doctor's paper I was looking for with interest and did not find.

I agree with what Dr. Paddock has said about the general diet and all the elements of food, the basis on which they are founded, and the knowledge we possess both physiologically and dietetically.

Dr. Eugene Cary: There was one thing that came up in my mind in connection with this paper, namely, Dr. Paddock stated that if the consumption of water was increased it would influence the fœtus. I recall to mind a case I saw in California a few years ago which corroborates what he said, and for that reason I think in these cases it is important not to overcrowd the calcium intake of the mother. This tuberculous woman, a doctor's wife, became pregnant. The water in southern California is full of lime salts, to begin with. She was given medicine rich in lime salts which caused ossification to take place in the fœtus to some extent, and the bones of the head were practically comparable to those of a child of 6 months, necessitating a difficult delivery. The fontanelles closed early, and that was directly influenced by the large doses of calcium the woman took during pregnancy.

Another point that was not brought out sufficiently in this paper is the fact that we should watch for the increased acidity in the mother, which can be regulated to a great extent through the diet. I have been in the habit of watching my cases for the degree of acidity in the specimens of urine, and in that way I think I can control some of the toxæmias that otherwise might prove serious.

DR. N. SPROAT HEANEY: As I understand, the burden of Dr. Paddock's paper is that the size of the fœtus cannot be regulated by the mother's food. That is pretty hard to demonstrate clinically because there are different things that influence the size of the child besides the food. Heredity and illnesses are factors which should be considered besides the food intake. The number of pregnancies in a given individual are so small that we have very little comparison between different children from the same mother as a basis for clinical control of the effects of the food. In animals we have subjects for experimentation. Where there are numerous offspring or various litters, or various aspects of single ova, the effect of food can be more carefully determined.

A fact that came to me recently while on a trip was that scientific poultrymen can, by the food they give their fowls, regulate very largely the size of the ovum, and what was more interesting to me was that they could determine the interrelation between the yoke and white of the egg up to within a certain limit, so that for the New York market, for instance, they produced eggs of certain requirements to get fancy prices for them by the special foods which they gave their fowls. In the chicken the ovum and sustenance for the development of the embryo are all deposited inside of a membrane and the sustenance is fixed on the ova as shad; while in the animal the ovum contains only a partial amount of the content which the embryo needs for its development, so that it would have a different influence. That fact in connection with poultry is, at least, interesting, although it does not pertain exactly to the subject at hand.

In animal husbandry the farmer believes that there is a direct influence between the amount of food consumed, particularly the nature of the food, and the size and strength of the offspring of the animal; that if the animal does not get a well balanced ration it is weak; it is liable not to survive; that weak litters of pigs in particular are produced by not giving a well balanced ration. It is well known that when hogs are allowed to roam wild, especially in summer time, the litters are stronger because the pig has the capacity to select its own diet fairly well. If it is given all the different foods it needs, it will select the best balanced ration. Where the farmer gives the pig a certain amount of food and does not allow the excess of all combinations of proteins, fats, and carbohydrates, the hog does not do so well and is liable to have weak litters. Whether that has ever been determined scientifically in the experiment station, I am not prepared to say.

I know it is the general impression among farmers that food is a very important thing in determining the size and strength of the offspring at birth. It is well known that if cows do not get the proper food they will not yield the proper milk supply. If an animal is not well nourished after birth the offspring will not do so well.

DR. ARTHUR H. CURTIS: I would like to ask Dr. Paddock whether he knows of or has any statistics in regard to the condition and weight of the children born during the starvation period of the war, or when the diet of the mothers was extremely limited?

DR. FRANK CARY: In farm work it is well known that if pigs are overfed, the progeny will not be strong. A pig that wanders around and has to scratch for his own living, getting a varied diet is a much better pig than he would otherwise be. For two years I have been raising fancy pigs and have fallen down because I have overfed them.

Regarding the subject of diet in pregnancy, I was in hopes Dr. Paddock would tell us whether anything definitely had been determined as to the ability to lessen the size of the child by reducing the fats and sugar in the food of women in the later stages of pregnancy. I am very skeptical on the subject of feeding in pregnancy when I see children born in the northern wilds where the mothers live on a meat diet and fats entirely, and the children are pretty hard to raise. Again, when I see people fed largely on a vegetable diet in hot climates, I find the average from the standpoint of offspring is pretty much the same. Food has to be modified by climatic conditions. You cannot feed people in northern climates on the same foods and keep them alive as you use in hot climates. The offspring seems to be able to survive, even though the parent suffers greatly in diet.

I have tried for several years to feed my patients on fats and carbohydrates in the latter part of pregnancy, thinking possibly I could get some definite ideas of whether the children would be small or not, but the fallacy of the whole thing is that we cannot depend upon the patients. You can draw conclusions, but when you ask the patient what she has been eating you do not get a satisfactory answer. I do not see how we are going to get definite figures on that account unless we can control the diet of these women the same as we do our animals.

DR. JOSEPH L. BAER: I am still in a waiting frame of mind on the question of diet in pregnancy. I had hoped Dr. Paddock would help me to reach a conclusion in that regard. An article appeared some months ago from Dr. Ehrenfest, of St. Louis, which was apparently rather conclusive, and still I am restricting primiparæ in the last 6 to 8 weeks of pregnancy in the matter of diet, cutting down their carbohydrate and fat intake, and waiting to reach a conclusion of my own. I believe with Dr. Cary the crux of the situation lies in the inability to control the patient entirely. I have tried both ways, the one of suggesting a tentative amount of food to the patient and allowing her a certain latitude, prescribing a diet of inclusions and exclusions, and in neither set of cases did it seem to convince me. I think we are all agreed, however, that in the presence of toxæmia, the nitrogenous intake should very definitely be restricted.

DR. PADDOCK (closing): I have read a great deal about the work of different physiologists on this

subject, and almost to a man they have come to the conclusions I have given, that the fœtus will thrive at the expense of the mother, regardless of the food given; that there is a constant storing up of food elements in the body during pregnancy, if the woman is normal and has been on a normal diet. If she has not been on a normal diet, she has not enough reserve force for the fœtus to thrive upon. The fœtus will thrive at the expense of using up that reserve force of the mother. If there is no more reserve force, the fœtus will continue to thrive until that force becomes exhausted, and, at the same time, the mother will either lose her life, or her life will be greatly injured.

Let us take as an illustration pigs that are poorly fed, or a mother that is poorly fed. Pigs will thrive, become large and grow fat up to a certain point, but finally they lose because they are using up the mother's reserve force.

I could not go into the subject as thoroughly as I would like to have done.

In regard to the question of Dr. Curtis, I have seen some war statistics, but cannot give them exactly, in regard to babies being born in Europe at the present time, and it is claimed there is some reduction in the weight of these children. I think that Pinard has reported several thousand cases where there seemed to be a loss of weight on the part of the children, but whether those statistics refute my statement or not, I do not know.

Dr. Frank David read a paper on "Diagnosis and Treatment of Minor Rectal Lesions."

BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Principles of Human Physiology. By Ernest H. Starling, M.D., Hon. Sc.D. (Cambridge and Dublin), F.R.C.P. 3d ed. Philadelphia: Lea & Febiger, 1920.

L'ernia inguinale nell' infanzia. By Prof. Gerolamo Gatti, Director of the Surgical Pediatric Clinic, Florence. Bologna and Trieste: L. Cappelli, Editore, 1920.

Gli abdominali di guerra. By N. Giannettasio. Bologna and Trieste: L. Cappelli, Editore, 1920.

A Textbook of Dermatology. By J. Darier. Authorized translation from the second French edition, edited with notes by S. Pollitzer. Philadelphia and New York: Lea & Febiger, 1920.

Regional Anesthesia (Victor Pauchet's Technique). By B. Sherwood-Dunn, M.D. Philadelphia: F. A. Davis Company, 1920.

Transaction of the American Association of Genito-urinary Surgeons. 1919, vol. xii.

Gynæcology for Students and Practitioners. By Thomas Watts Eden, M.D., F.R.C.S. (Edin.), F.R.C.P., (Major, R.A.M.C.), and Cuthbert Lockyer, M.D., B.S., F.R.C.S., F.R.C.P. 2d ed. New York: The Macmillan Company, 1920.

A Manual on Foot Care and Shoe Fitting for Officers of the U. S. Navy and U. S. Marine Corps. By W. L. Mann, Ph.B., A.M., M.D., and S. A. Folsom, M.D. Philadelphia: P. Blakiston's Son & Co., 1920.

Industrial Medicine and Surgery. By Harry E. Mock, B.S., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1919.

Common Diseases of the Skin; with Notes on Diagnosis and Treatment. By G. Gordon Campbell, B.Sc., M.D., C.M. New York: The Macmillan Company, 1920.

Surgical Shock and the Shockless Operation through Anoci-Association. By George W. Crile, M.D. and William E. Lower, M.D. 2d ed., thoroughly revised and rewritten. Philadelphia and London: W. B. Saunders Company, 1920.

The Treatment of Syphilis. By H. Sheridan Baketel, A.M., M.D. New York: The Macmillan Company, 1920.

Diseases of Women Including Abnormalities of Pregnancy, Labor, and Puerperium; a Clinical Study of Pathological Conditions Characteristic of the Five Periods of Woman's Life Presented in 173 Case Histories. By Charles M. Green, A.B., M.D. Boston: W. M. Leonard, Publishers, 1920.

Publications of Cornell University Medical College; Studies from the Departments of Pathology, Bacteriology, and Hygiene. New York City: 1916-1918, vol xvi.

Handbook of Diseases of the Rectum. By Louis J. Hirschman, M.D., F.A.C.S. 3d ed., revised and enlarged. St. Louis: C. V. Mosby Company, 1920.

Transactions of the American Surgical Association. Vol. xxxvii. Edited by John H. Jopson.

Transactions of the American Gynecological Society. vol. xliv. Edited by George Gray Ward, Jr.

Arteriosclerosis and Hypertension with Chapters on Blood Pressure by Louis M. Warfield, A.B., M.D. (Johns Hopkins), F.A.C.P. 3d ed. St. Louis: C. V. Mosby Company, 1920.

Lippincott's Nursing Manuals. A Nurse's Handbook. By Joseph Brown Cooke, M.D. 9th ed. revised and enlarged by Carolyn E. Gray, R.N., and Philip F. Williams, M.D. Philadelphia and London: J. B. Lippincott Co., 1920.

Pensions and the Principles of Their Evaluation. By Llewellyn J. Llewellyn, M.B. (Lond.), and A. Bassett Jones, M.B. (Lond.), with section on Pensions in Relation to the Eye. By W. M. Beaumont. St. Louis: C. V. Mosby Company, 1919.

AMERICAN COLLEGE OF SURGEONS

NOTES ON HOSPITAL STANDARDIZATION

WESTERN HOSPITAL ASSOCIATION ACTS ON STANDARDIZATION

HOSPITAL standardization and the betterment of hospitals generally are live subjects in Canada. This is true especially in Western Canada. Both the medical profession and the public in the provinces of Western Canada realize their inter-dependence more vividly than do the people in any of the other commonwealths on the continent; they realize that only by close mutual understanding and team-work can they bring about a service which will really provide the right to be well.

On April 26 and 27 a conference was held at Calgary which was attended by representatives of the hospitals of Manitoba, Saskatchewan, Alberta, and British Columbia, by Fellows of the American College of Surgeons, and by other doctors and hospital workers. By a formal resolution this conference adopted the minimum standard of hospital standardization of the College, the resolution reading as follows:

Be it resolved, that this conference of hospitals of Manitoba, Saskatchewan, Alberta, and British Columbia, now in session in the City of Calgary this 26 and 27th day of April, 1920, approve of the minimum standard of hospital standardization, and recommend that this minimum standard be adopted by the hospitals and hospital associations of the four Western Provinces.

It was further decided to make the conference a permanent institution to be known as the Western Hospital Association, the objects of which as stated are:

1. The promotion of the work of hospital standardization according to the requirement laid down.

2. The stimulation of hospitals generally to greater efficiency.

3. The promotion of co-operation and team-work among our hospital associations and institutions.

4. The acting as a clearing house for all the problems of our provincial associations.

Meetings are to be held annually in one of the four provinces named.

The following papers and addresses were presented at the conference:

Address—R. C. MARSHALL, Esq., Mayor of the City of Calgary.

Address—HON. A. G. MACKAY, K.C., M.P.P., Minister of Health of the Province of Alberta.

Hospital Standardization—DR. R. E. MCKECHNIE, F.A.C.S., Vancouver.

The Practical Application of Hospital Standardization in the "Open" Hospital—DR. M. T. MACEACHERN, General Superintendent, Vancouver General Hospital.

Discussion of Hospital Standardization and the Minimum Standard: (a) Staff Organization; (b) Medical Case Records; (c) Laboratories.

REPORTS ON HOSPITAL ORGANIZATION

Manitoba—DR. GEORGE STEPHENS, Superintendent Winnipeg General Hospital.

Saskatchewan—DR. M. M. SEYMOUR, Commissioner of Public Health, Regina.

Alberta—DR. JAMES C. FYSHE, Superintendent, Royal Alexandra Hospital, Edmonton.

British Columbia—DR. M. T. MACEACHERN, General Superintendent Vancouver General Hospital, Vancouver.

A list of delegates of the hospitals represented follows:

Alfred, Sister Mary	Providence Hospital
Anthony, Mrs., R. N.	Holy Cross Hospital
Archer, A. E., M.D.	Lamont Public Hospital
Avidson, O. R.	Severance Union Medical College and Hospital
Bonde H., M. D.	Alberta Sanitorium
Boyd, Miss J. M., R. N.	Calgary General Hospital
Clinite, H. E., M.D.	Municipal Hospital
Deane, R. B.	Calgary General Hospital
De Satye, Lucille, R. N.	Holy Cross Hospital
Jube, Sister M. A., R. N.	St. Paul's Hospital
Duckett, Sister M. A., R. N.	Holy Cross Hospital
Dutton, E. E.	Galt Hospital
Edy, Lottie M., R. N.	Calgary General Hospital
Gibson, H. A., M.D.	Calgary General and Holy Cross Hospital
Glavin, Miss C., R. N.	Holy Cross Hospital
Hardie, W. D. L.	Galt Hospital
Irene, Sister Mary, R. N.	Providence Hospital
Lincoln, W. A., M.D.	Calgary General and Holy Cross Hospital
MacEachern, M. T., M. D. C. M.	Vancouver General Hospital
MacEachern, J. S., M.D.	Calgary General and Holy Cross Hospital
Mackay, Miss C., R. N.	Calgary General Hospital

McKechnie, R. E., M.D.	Vancouver General Hospital
Mackid, L. S., M.D.	Calgary General and Holy Cross Hospital
MacLaren, Dr.	Calgary General and Holy Cross Hospital
Patterson, G. E.	Regina General Hospital
Peterson, Geo. R., M.D.	
Quenneville, Sister M. A. L.	Holy Cross Hospital
Richardson, J. M.	Calgary General Hospital
Ross, D. E., M.B.	General Hospital
Rothwell, O. E., M.D.	Regina General Hospital
Seymour, M. M., M.D.	Commissioner of Public Health
Stephens, George F., M.D.	Winnipeg General Hospital
Tafard, Sister M., R. N.	Holy Cross Hospital
Taggart, A. M.	Calgary General Hospital
Upton, W. W., M.B.	Holy Cross and Calgary General Hospital
Warren, J. W., M.D..C.M.	Calgary General Hospital
Whale, Miss H., R. N.	Calgary General Hospital
Wharton, H. A.	Holy Cross Hospital

HOSPITAL PROGRESS MAGAZINE

AS an out-growth of the interest of Catholic hospitals in hospital standardization, comes now the first number of *Hospital Progress*, the official magazine of the Catholic Hospital Association. The magazine is inspiring evidence of the headway which the great group of Catholic hospitals is making toward better care of patients. Among the contributors to the first number (May) are Dr. B. F. McGrath, Dr. John T. Bottomley, Dr. A. J. Ochsner, Dr. C. H. Mayo, Dr. Michael F. Fallon, Dr. Hugh McKenna, Dr. S. S. Goldwater, and Dr. Donald Guthrie.

The executive committee of the board of editors is composed of Charles B. Moulinier, S. J., Milwaukee; Dr. B. F. McGrath, Milwaukee; Dr. Edward Evans, LaCrosse; Dr. Frederick A. Stratton, Milwaukee; and Dr. Edward L. Tuohy, Duluth. The contributing editors of the board are Dr. John T. Bottomley, Boston; Dr. Hugh McKenna, Chicago; Dr. Frank S. Wiley, Fond du Lac; Reverend Michael P. Bourke, Ann Arbor; Reverend Maurice F. Griffin, Youngstown; Dr. Horatio B. Sweetser, Minneapolis; Dr. Austin O'Malley, Philadelphia; Dr. Edward T. Dillon, Los Angeles; Dr. Michael F. Fallon, Worcester; Dr. William C. MacCarty, Rochester; Dr. James J. Walsh, New York City; Rt. Reverend Joseph Schrembs, Toledo; Dr. Eugene Saint-Jacques, Montreal; Dr. J. Alexandre, Saint-Pierre, Montreal; Dr. Joseph Byrne, New York City; Dr. Irvin Abell, Louisville; Reverend Peter P. Finney, Dallas; and Reverend P. J. Mahan, Chicago.

The leading editorial of the first number reads:

"Herewith the Catholic Hospital Association of the United States and Canada presents to its membership, to the medical profession, to the hierarchy of the Catholic Church, to the Catholic clergy, to the hospital world and to the general public, the first number of its official organ, *Hospital Progress*. It is to be a monthly magazine. Its board of editors will eventually be representative of all sections of this country and Canada. Therefore, too, the technical views, aims and policies of *Hospital Progress* will necessarily grow out of the varied and numerous experiences and circumstances of heterogeneous population, diversified climate, a medical profession of widely differing training and experience, a body of sisters from many religious orders differing in customs, habits, traditions and occupations. This will inevitably lead to varying and sometimes conflicting opinions, needs and methods. There is, however, a common ground of minimum scientific requirement formulated by the American College of Surgeons—organization, records, and laboratory equipment—which every hospital can stand on, whether large or small, prosperous or struggling, since it calls for expenditure of effort rather than of money."

STANDARDIZATION AND THE PUBLIC

THE *World's Work* for June contains an article on hospital standardization which is of interest to hospitals, to the medical profession, and to the public. Especially is the article significant of new public interest in hospitals. In telling the story of the campaign for betterment of hospitals, or what is known as hospital standardization, Mr. Hawthorne Daniel, the writer, says:

"There were public and private hospitals, Catholic and Protestant hospitals, city and state hospitals, and a host of others, each with its own ideas as to hospital management, each with prejudices against outside interference.

"On the other hand was the American College of Surgeons, with an idea, but no authority to force its point and no 'rights' in any hospital.

"At this point in the story comes the intangible factor: Why did the hospitals and why did the entire medical profession enter into wholehearted co-operation with the program of the College? First, the very doctors who are most earnest for the success of the work are themselves practicing in the hospitals. The 'reform' therefore springs from within the hospitals and is not 'reform' brought to them from without. There is a big difference between these two

things. Second, there is nothing new, nothing even debatable in the entire program—it is merely the vitalization of ideals tried through centuries and proven sound. Third, back of the the program is courage, kindliness, patience, strong personalities, and never a doubt as to ultimate success.

"The primary purpose of nearly all hospitals is the care of the sick or injured. This means that, as a matter of policy, the hospital seeks to render to each patient admitted, the most efficient care known to the staff of the hospital. Hospitals and doctors accept this interpretation; otherwise the hospital would be merely a boarding-house for the sick or injured. Further, the trustees of the hospital, having accepted this policy, are responsible for the administration of the policy; and the people of the community have a right not only to assurance that the policy is carried out, but also to the facts upon which such assurance is based. It is only upon such a relationship of mutual confidence that the hospital may reasonably ask the good will and support of the community. Again, upon such a relationship rests the ultimate success of the hospital. The minimum standard is designed to foster just this fundamental relationship.

"The medical profession is largely made up of men who are practical idealists. Sometimes, under the forces of circumstance, some of them may not have held entirely true to their own ideals, but it seems difficult to believe that many of them have ever allowed their ideals completely to lose control. And with the program of the College to supplement their own beliefs they are throwing aside those methods that are open in the least to criticism, and of their own volition have renewed and increased their efforts to bring about the reforms in which they always have believed.

"And it is with this elusive force that the College has worked with such success. With the ideal of the profession visualized, and with practical plans made to insure their application, the country may confidently look forward to a new era that is already partly here; when the hospitals of America will be institutions for service, from which selfish interest and careless methods have been abolished, and to which the country may look for considerate and efficient treatment, confidently expecting and receiving the utmost that the medical profession is capable of giving."

PERTINENT QUESTIONS FROM NURSE

HOW often are patients "just cases"? Is there any possible advantage, either to the science of medicine or to the patient, that the patient be just a "case"? With this idea in mind, a nurse in Alabama writes:

"My interest, enthusiasm, and work in the medical profession dates back many years and for the past 10 years, I have been making a study of hospitals and their management. Every physician admits that without proper facilities, his work is practically in vain and as my career as a nurse now seems over, I believe I can take an impartial view of the matter.

"I read, write, and in every possible way try to get at the root of present trouble in securing that very necessary facility, 'the nurse.' We must standardize our hospitals in such a way that the nurse does not become merely a machine. The great criticism today of my beloved Alma Mater, is that the patients are handled merely as business propositions. Patient after patient has come away telling of the efficiency of the hospital from the business point of view; and then they add: 'They treated me as a *case*, nothing more.' That is a wide-spread criticism. Is it not founded on fact? Can we not, in building our hospitals, add something which will make the life of the nurse more attractive, and at the same time create a quality of service which will make the work of the surgeon trebly successful?"

ORGANIZATION OF STATE AND PROVINCIAL CLINICAL SECTIONS OF THE CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

IN order to promote within the individual states and provinces the purposes for which the American College of Surgeons was founded, the Board of Regents of the College has authorized the organization of clinical sections in each of the states of the United States and the provinces of Canada.

In this connection, the following suggestions have been compiled for the purpose of providing a standardized organization for all sections of North America:

CLINICAL SECTIONS

Each clinical section shall consist of the Fellows of the American College of Surgeons resident within the given state, and shall be known as "The (name of state) Clinical Section of the American College of Surgeons."

The section shall vest the general management of all state matters in a body of state representatives.

STATE REPRESENTATIVES

The state representatives shall consist of one representative for each congressional district, and two senatorial representatives at large, each to be elected by the Fellows of the state for a term of two years, one-half of the number to be elected each year by ballot through the central office two weeks before the annual meeting of the national Clinical Congress. This body will correspond in the state to the Board of Governors of the College. Similar organizations will be effected in the provinces of Canada.

The state representatives shall meet in executive session annually for the transaction of such business as may be brought before them by the executive committee. Such meetings shall be called by the secretary of the executive committee, at the direction of the committee as a whole. A majority of the state representatives shall constitute a quorum for the transaction of business.

In the event of the death, resignation, or withdrawal from the state of a state representative, his successor shall be elected at the next regular or special meeting of the state representatives; but the executive committee may appoint a Fellow in the state to serve until such election takes place.

EXECUTIVE COMMITTEE

At the annual meeting of the state representatives, an executive committee, to consist of from three to five Fellows, shall be elected from among the state representatives. The executive committee shall correspond to the Board of Regents of the College and be the supreme executive body within the state.

The officers of the executive committee shall be a chairman and a secretary who shall serve for a term of one year. The chairman shall preside at all meetings of the executive committee and of the state representatives, and be the president of the annual sessions of the clinical section. The secretary shall act also as the secretary of the state representatives and the state section. In the event of the death, resignation, or withdrawal from the state of the chairman, a counselor, to be known as vice-chairman, shall assume the duties of the chairman until that office is filled by election at the next meeting of the state representatives.

The duties of the executive committee shall be those ordinarily performed by a governing board, namely:

1. To create, appoint, and direct all committees;
2. To call all meetings of the section not already provided for;
3. To conduct annual state clinical meetings as hereinafter provided;
4. To transact all detail business devolving upon the state representatives in carrying out the object of the organization;
5. To transact all business not already provided for that may pertain to the organization;
6. To direct the manner in which the books and accounts of the section shall be kept, and cause to be examined from time to time the accounts and vouchers for moneys received and paid out, and submit the same to the central office for approval;
7. To keep a record of state proceedings, and submit a report regarding such proceedings to the state representatives for approval at the next succeeding meeting, and to the central office.

The executive committee shall hold meetings at such time and place as it may from time to

time determine. A majority of the members of the executive committee shall constitute a quorum for the transaction of business.

ANNUAL SESSIONS

The section shall hold an annual session of from two to three days at such time and place as may be determined upon by the executive committee, which may include:

1. Surgical and diagnostic clinics and clinical demonstrations to be conducted during the mornings by Fellows of the College, and invited associates, of the city in which the meeting is held; these clinics to provide for practical demonstrations of the group method of diagnosis and teaching, in co-operation with internists, pathologists, roentgenologists, and other specialists of medicine;

2. Afternoon meetings for the laity, to be addressed by invited laymen and surgeons;

3. Scientific and literary papers relating to the art and science of surgery, to be presented at evening meetings by local surgeons of prominence and by invited guests from outside of the state or province;

4. Annual meeting of the state section, of the state representatives, and of the executive committee.

COMMITTEE ON INVITATIONS. The committee on invitations shall determine the list of invited guests, based upon the following:

Attendance at the clinical sessions shall be limited to Fellows of the College and invited guests, the latter to include candidates for fellowship approved ethically by the respective State Credentials Committee, and include also internists, pathologists, roentgenologists, sanitarians, editors of medical journals, and other medical men of influence.

Invitations to attend the afternoon and evening sessions shall be extended to the Chamber of Commerce, Rotary Club, Women's Club, and other prominent lay individuals and organizations.

COMMITTEE ON ARRANGEMENTS. The committee on arrangements shall visit the hospitals in the city in which the meeting is to be held, and determine if their combined clinical facilities will accommodate the estimated number of guests and Fellows who will attend the meeting, as reported by the committee on invitations.

This committee shall consider hotel accommodations and ascertain if the facilities of the city in this connection will provide amply for the entertainment of all guests and Fellows who expect to attend. The hotel selected for headquarters should provide:

1. A ball-room or assembly hall for afternoon and evening meetings;

2. A room adjoining, to be used as a registration and ticket bureau;

3. A corridor to be used for the display of clinical bulletins.

Note.—2 and 3 may be the same room if it is large, and it is desirable that all of these rooms should be on the same floor.

The committee on arrangements shall select a capable young surgeon to serve as editor of the daily clinical bulletin, and a press committee which shall edit and revise the reports of all clinical proceedings for transmission to the medical and lay press.

HOSPITALS. Each hospital in which clinics are to be given shall appoint a committee of three, representing all services, which shall be responsible for the conduct of the clinics held in the hospital. One member of this committee shall be specifically charged with the duty of telephoning or otherwise transmitting each afternoon to the bulletin editor at headquarters the list of the coming day's clinics. Each hospital shall provide an individual who shall honor or take up the tickets issued at headquarters for each specific demonstration.

CO-OPERATION OF CENTRAL OFFICE. A representative from the central office will work with the executive committee and co-operate as far as may be necessary in carrying out the details of arrangements at headquarters, prepare tickets, clinical bulletins, etc., and assist in the smooth running of the meetings.

The central office will aid through recommendations in the selection not only of prominent clinicians but also of speakers of note for the afternoon and evening meetings. To this end it is essential that the secretary of the executive committee shall at all times keep in close touch with the central office of the College.

CO-OPERATION OF THE PRESS. Impersonal, ethical publicity is essential in order that the state clinical meetings may exercise the widest influence. To this end, the press committee, appointed by the committee on arrangements, shall see to it that invitations to all open meetings and summaries of daily clinical bulletins are given to properly selected sources of publicity.

All reports of actual clinical procedure submitted to the public press shall be carefully censored by the press committee, which shall see that nothing is published which does not conform to the strictest standards of professional ethics.

FINANCES. It is the wish of the College that no extra expense shall be borne by the members of the College in the city in which the meeting is to be held. An allowance of not to exceed $3.00 per year for each member of the College in the state will be made by the central office to help defray the expenses of conducting the state meeting. There will be no individual registration fee. Exhibits by publishing houses and dealers in surgical instruments and supplies may be arranged for at the discretion of the executive committee.

STATE SECTIONS ALREADY ORGANIZED

During the month of May state sections of the Clinical Congress of the American College of Surgeons were formally organized in North Carolina, Pennsylvania, and Illinois.

The Executive Committees and Congressional Representatives of these states are as follows:

NORTH CAROLINA

EXECUTIVE COMMITTEE

Chairman, Jacob F. Highsmith, Fayetteville
Secretary, J. Wesley Long, Greensboro
Counselor, Hubert A. Royster, Raleigh

REPRESENTATIVES, Term expiring 1920

Senatorial, Samuel H. Lyle, Franklin
2nd District, James Marion Parrott, Kinston
4th " Hubert A. Royster, Raleigh
6th " Robert B. Slocum, Wilmington
8th " James Ernest Stokes, Salisbury
10th " Marshall H. Fletcher, Asheville

Term expiring 1921

Senatorial, Andrew J. Crowell, Charlotte
1st District, Julian M. Baker, Tarboro
3rd " Richard N. Duffy, Newbern
5th " Charles W. Banner, Greensboro
7th " John Wesley Long, Greensboro
9th " Albert M. Whisnant, Charlotte

PENNSYLVANIA

EXECUTIVE COMMITTEE

Chairman, Edward Martin, Philadelphia
Secretary, Donald Guthrie, Sayre
Counselor, William L. Estes, Bethlehem

REPRESENTATIVES, Term expiring 1920

Senatorial, John G. Clark, Philadelphia
2nd District, William E. Ashton, Philadelphia
4th " John H. Jopson, Philadelphia
6th " E. E. Montgomery, Philadelphia
8th " Robert G. LeConte, Philadelphia
10th " Jonathan M. Wainwright, Scranton
12th " George R. S. Corson, Pottsville
14th " Donald Guthrie, Sayre
16th " Harold Leighton Foss, Danville
18th " George B. Kunkel, Harrisburg
20th " Edmund W. Meisenhelder, Jr., York
22nd " John C. Cope, Greensburg
24th " Albert E. Thompson, Washington
26th " William L. Estes, Bethlehem
28th " Clifford C. Marshall, Sharon

REPRESENTATIVES, Term expiring. 1920—*continued.*

30th District, Otto C. Gaub, Pittsburgh
32nd " William O'Neill Sherman, Pittsburgh
At Large John J. Buchanan, Pittsburgh
At Large Charles B. Penrose, Philadelphia

Term expiring 1921

Senatorial, John Walter Park, Harrisburg
1st District, Ernest Laplace, Philadelphia
3rd " Edward P. Davis, Philadelphia
5th " Barton C. Hirst, Philadelphia
7th " Richard C. Casselberry, Chester
9th " John Light Atlee, Lancaster
11th " Lewis H. Taylor, Wilkes-Barre
13th " Charles D. Schaeffer, Allentown
15th " Harry J. Donaldson, Williamsport
17th " John R. W. Hunter, Lewistown
19th " John B. Lowman, Johnstown
21st " Evan O'Neill Kane, Kane
23rd " Daniel S. Rice, Ebensburg
25th " Harrison A. Dunn, Erie
27th " John W. Dixon, Wilkinsburg
29th " R. R. Huggins, Pittsburgh
31st " George L. Hays, Pittsburgh
At Large Edward Martin, Philadelphia
At Large George E. de Schweinitz, Philadelphia

ILLINOIS

EXECUTIVE COMMITTEE

Chairman, Carl E. Black, Jacksonville
Secretary, Charles E. Kahlke, Chicago
Counselor, O. L. Pelton, Sr., Elgin

REPRESENTATIVES, Term expiring 1920

Senatorial, E. Wyllys Andrews, Chicago
2nd District, John R. Pennington, Chicago
4th " George Willard Green, Chicago
6th " Harry John Stewart, Oak Park
8th " Carl Beck, Chicago
10th " William Ross Parkes, Evanston
12th " Joseph W. Smith, Bloomington
14th " Joseph Barnes Bacon, Macomb
16th " Charles H. Brobst, Peoria
18th " Frank M. Mason, Rossville
20th " Carl E. Black, Jacksonville
22nd " Charles H. Starkel, Belleville
24th " William F. Grinstead, Cairo
At Large Thomas J. Watkins, Chicago
At Large O. L. Pelton, Sr., Elgin

Term expiring 1921

Senatorial, William R. Cubbins, Chicago
1st District, Charles E. Kahlke, Chicago
3rd " Hugh McKenna, Chicago
5th " Albert J. Ochsner, Chicago

REPRESENTATIVES, Term expiring 1921—*continued.*

7th	District,	Allen B. Kanavel, Chicago
9th	"	Paul Oliver, Chicago
11th	"	Raymond G. Scott, Geneva
13th	"	Jeremiah H. Stealy, Freeport
15th	"	Ralph Charles Matheny, Galesburg
17th	"	Samuel M. Wylie, Paxton
19th	"	James S. Mason, Urbana
21st	"	George N. Kreider, Springfield
23rd	"	Jonathan L. Wiggins, E. St. Louis
25th	"	Henry C. Mitchell, Carbondale
At Large		Frederic A. Besley, Chicago

Clinical sections have now been organized in the following states:

North Carolina	Arizona
Louisiana	California
Texas	Oregon
Utah	Tennessee
Colorado	Kentucky
Missouri	Ohio
Washington	Indiana
Idaho	Pennsylvania
Montana	Illinois

Several of these states have announced the date of their first annual meeting.

North Carolina claims precedence in the organization of state sections of the Congress, having tentatively effected its clinical section in November, 1919.

The Secretary-General of the American College of Surgeons is proceeding as rapidly as possible with the organization of the other states and provinces.

SOUND DEADENING IN HOSPITALS

By RICHARD E. SCHMIDT, F.A.I.A., Chicago

NOISE in any form is obviously objectionable about a hospital; whether or not it is caused by the slamming of doors, the operation of the elevators or ventilating machinery, or by persons walking, by conversation, or by a patient in pain. Complaints regarding this annoyance are heard about almost every hospital to a greater or less extent; probably more today than years ago before the use of fire-resisting construction was so general.

Quiet in hospitals is not a matter of architectural acoustics, which are determined by the form and furnishings of rooms. The acoustics of halls, theaters, etc., are among the rational engineering problems and perfect acoustical qualities, that is, perfect hearing by every listener can be predetermined; in hospitals, however, the problem is quite another matter.

The floors, partitions, and walls of buildings of combustible construction, which appear to be less noisy, are constructed of many pieces and have interior air spaces. Building felts and other combustible materials are used. Such construction is not permissible in fire-resisting construction, except to a minor extent. The numerous air spaces, which help in preventing the passage of sound, form flues and shafts which accelerate the travel of fire.

Fire-resisting construction of any kind is practically vermin-proof, and does not contain the numerous continuous air spaces which afford runways for mice and rats and, therefore, has another point in its favor over combustible construction.

The older form of fire-resisting construction, viz., structural steel beams and hollow tiles, also contained many air spaces. This construction was also fairly sound-proof. With the advent of reinforced concrete construction and the use of a very few hard materials, buildings were soon found to be unusually noisy. The first concrete buildings had solid floor slabs with finished cement floor surfaces and plaster on the under or ceiling side. Therefore, in substance, there was only one material, sometimes only a few inches in thickness, between two stories; hence, sound was easily transmitted from one floor to the other. The so-called sanitary floors, such as magnesia composition, terrazzo, and tile, are also dense and comparatively thin, so that their use does not decrease the travel of sound to any considerable extent when used on such construction.

Newer forms of reinforced concrete construction, in combination with hollow clay tile, gypsum

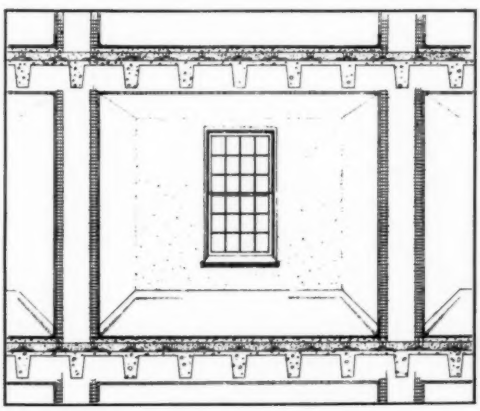


Fig. 1. Cross section of ideal construction.

Fig. 2. Diagonal view of one of the Evanston sound-proof doors.

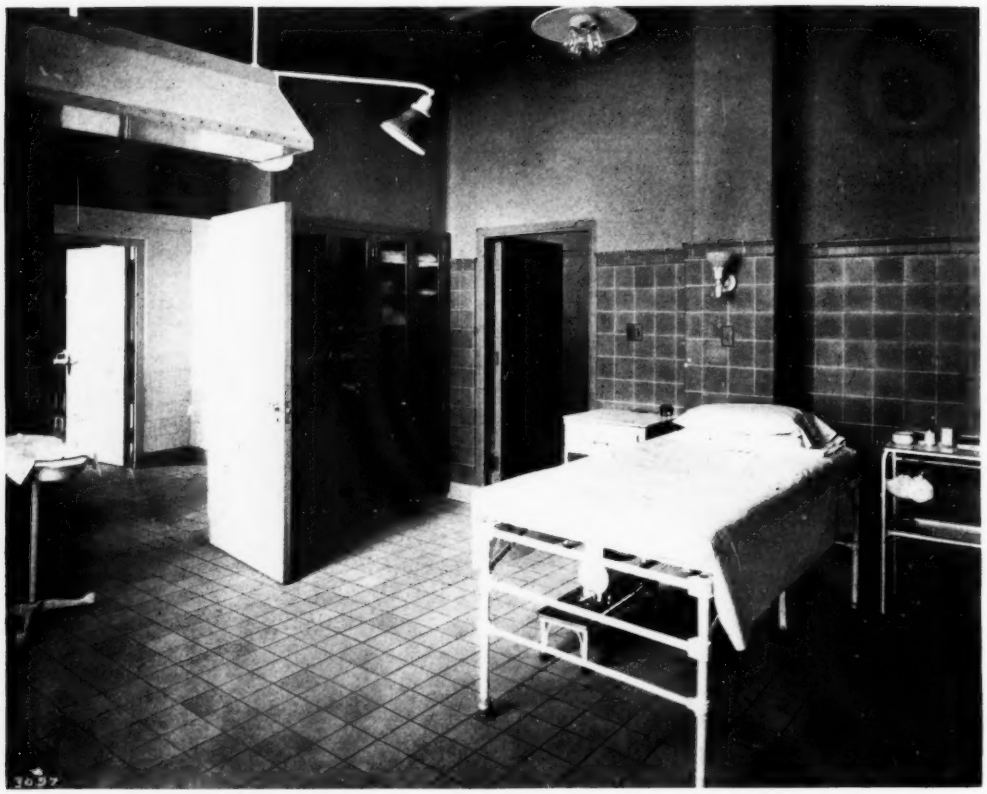


Fig. 3. Chicago Lying-In Hospital, birth room. The doors on the left and right are sound proof. Note thickness and lever handles.

domes, or steel forms which require suspended metal lath and plaster ceilings, provide additional air spaces, which better the condition. Such forms of construction, when used in hotels and apartment houses, are quite satisfactory because of the use of carpets, rugs, and heavy padding under the carpets. Reinforced concrete construction is considerably cheaper than hollow tile and steel, and has almost completely supplanted the latter, because of the greatly enhanced cost of building.

The problem of sound insulation or elimination is a difficult one, and it is necessary to provide sound-absorbing materials. For complete insulation the deadening material must be so thick as to be prohibitive, although relatively thin layers produce an appreciable reduction in intensity of sound transmitted.

Complete absorption of sound, or the prevention of its travel from one room to another, would probably require an arrangement consisting of finished rooms completely insulated or separated from the rooms adjoining on the sides, from the corridors and from the rooms above and below. Such an arrangement may be viewed by conceiving a complete building with all unfinished walls, floors, and partitions in place with another finished set of rooms within the rough structure but not in contact with it. Obviously this is impossible, for the inner finished floors, walls, and ceilings must be supported on the structural floors; but the floors, walls, and ceilings can be placed on sound-absorbing cushions, with sound-absorbing connections in doorways and windows. In this way a complete air space will be constructed around the room, as shown in Figure 1. Such an arrangement will not be sound-proof, however, unless the materials in the floors, partitions, and walls are of such a nature and thick-

Fig. 4. Chicago Lying-In Hospital.

ness that sound will not travel across the air spaces.

It is apparent that such a building will virtually consist of two buildings, i.e., it would require almost double the amount of material and labor, and cost twice as much as the ordinary building; its cost is consequently prohibitive.

The Wallace Clement Sabin Laboratory of Acoustics at Geneva, Illinois, was built to exclude all sound from one portion to another, except as it passes through a wall the transmission of which is being studied. The securing of this condition is exceedingly difficult and the building essentially consists of two entirely separate structures under a single roof. This, together with the fact that it was necessary to build it of massive concrete and brick construction probably made its cost unusually great in proportion to the space enclosed. Heavy steel and ice box doors were used in lieu of ordinary doors. These doors were placed on two sides of vestibules which function as sound locks. Possible transmission from room to room by a common floor construction made it necessary that the rooms be separated clear to the foundation. The walls of these rooms are of solid masonry 18 inches thick, and the foundations consist of successive layers of sand, hollow tile, concrete, several layers of tarred paper, and a concrete wearing surface. Where contact was necessary, layers of felt were placed between adjoining walls, air spaces were left between walls, for, experience has shown that they afford more effective insulation than a reasonable thickness of felt or other absorbing material.

Pasteur's great discoveries were soon followed by a general demand for the use of impervious and non-shrinking materials for floors, walls, ceilings, and all other parts of a hospital, and labor costs required the use of materials which could be quickly and easily cleaned. This demand was met by manufacturers of all classes of building material by supplying dense hard plasters, enamel paints, glazed tiles, white glass, metal trim, metal doors, composition floors, terrazzo and tile floors, all of which excellently served the demand for easy and perfect cleansing; their use increased the difficulty for they have great sound-reflecting power and resist sound transmission very little. Consideration of only one of these materials, viz., wall plaster, will illustrate the effect of the demand. The old form of lime, sand, and hair or wood fiber was rather porous and absorbing but the modern cement wall plaster is much denser and harder, and hard glossy

Fig. 5. Michael Reese Hospital, exterior.

enamel paints increase its reflecting power and decrease its sound absorption.

Thick soft cartridge papers or Lincrusta Walton, or canvas covered felt may be suitable expedients in offices and homes, but are improper for hospital use.

Fire-resisting and sound-absorbing material which has an artistic appearance and which can be molded and ornamented to resemble coarse stone or terra cotta and made in thin slabs or blocks, is manufactured by the R. Guastavino Co., of New York. This material contains innumerable air cells and appears to consist of round grains resembling roe. It is eminently suitable for lobbies, entrances, chapels, and lecture halls, but too porous and expensive for general use in hospitals. It is easily soiled if used within 6 or 7 feet of the floor. Painting would decrease its absorbing power and destroys its natural pleasing color which requires no further finish for ornamental purposes.

To build complete partitions, walls and floors of sound-absorbing material of high efficiency is impracticable on account of expense or combustibility and in some cases structurally. It, therefore, appears necessary to build the structure and partitions of the materials generally used, which are the cheapest for building purposes, and to interline these building elements with layers or diaphragms of absorbing material which will produce an appreciable reduction in the intensity of the sound transmission.

Felt, felt paper, mineral wool, asbestos, and cork, all of which contain minute air cells, are quite effective. Any of these can be used in floors and covered on the wearing surfaces by tile, terrazzo, cement, etc., but it is difficult to use any of them except cork in connection with walls or partitions, for it is obvious that it would be necessary to build hollow partitions, the cost of which is usually double that of the single partition. Inasmuch as wall plaster and cement will adhere to cork and cork can be applied to one

Fig. 6. Piano Practice Hall of Northwestern University School of Music.

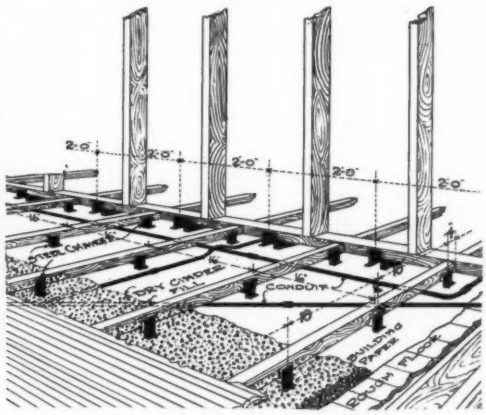


Fig. 7. Perspective of Stevens' system of floor deadening.

side of a partition or the underside of a ceiling, against walls and on floors, this material in the form of compressed sheets, appears to be the most suitable and reasonable in cost. It has been used successfully for all sides of operating, delivery, and labor rooms, and after the plastering and floor surfaces were applied their appearance does not differ from the ordinary tiled and plastered room.

Further to confine and absorb sound originating in these rooms, special sound-proof doors are used. These doors are built up of two thin wooden doors joined by small metal spacers forming an air space partially filled by a thick sheet of felt. The space between the two doors also contains a parallelogram of steel bars operated by the lever handle of the latch, which presses strips of compressed felt against the three sides of the frame and the floor when the door is closed and the lever is pushed downward, and simultaneously engages the door latch with the strike plate. Such doors are made under patents of Irving Hamlin, of Evanston, Illinois, and have functioned satisfactorily in Michael Reese Hospital and Lying-In Hospital, Chicago, and the Piano Practice Hall of Northwestern University School of Music (Figs. 2, 3, 4, 5, and 6).

This is a superior door for telephone booths, and inasmuch as it hermetically seals the opening it can also be used to advantage for vapor bath rooms, for communicating doors of suites and bath rooms and to facilitate fumigation or disinfection.

Nalecod, a proprietary combination of powdered and fibrous materials mixed with Portland cement, sand, and water, makes a plastic mortar that sets and forms a tough elastic mass filled with air cells, into which nails or screws can be driven as rapidly as into wood. It is vermin-proof, fireproof, light, and quite sound-absorbing and furnishes an excellent base for flooring of all kinds. Its elasticity compensates the varying rates of expansion and contraction of the structure of a building and composition, terrazzo, mosaic, tile, and other forms of flooring, and is, therefore, a valuable additional building material.

Hardwood flooring, if laid on Nalecod, in pieces 16 or 18 inches in length, in herringbone pattern, and thoroughly finished with wax affords an excellent sound-absorbing floor, which will not shrink to such an extent that it will have open joints of the dimensions which has made wood flooring in its ordinary form objectionable for modern hospital use.

Stevens' system of floor deadening (Figs. 7, 8, and 9) has been unusually successful for use in apartment houses and hotels where wooden floors have been used, and inasmuch as a filling of dry cinders is used in lieu of the customary moist filling, containing cinder concrete, wood floors do not shrink to the same extent as they do when used on the older form of construction. It consists of small metal supports or chairs, which are bedded in cement mortar about 18 inches apart and support wood nailing strips in U-shaped recesses lined with felt. These strips, to which the flooring is nailed, are placed 16 inches from center to center. The space between and under the nailing strips is filled with a course of clean dry steam boiler cinders to a depth of about 3 inches. Partitions can also be supported on similar chairs and assist greatly in stopping the transmission of sound.

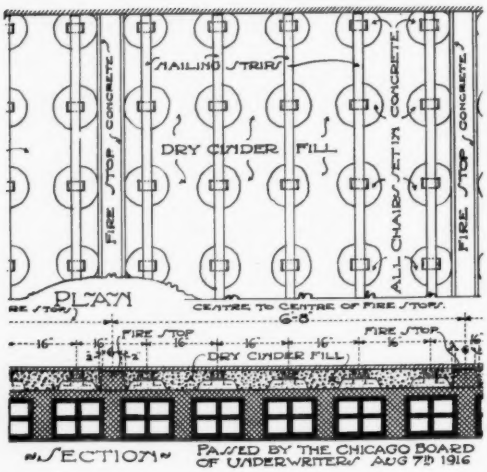


Fig. 8. Plan and section of Stevens' system of floor deadening on fireproof construction.

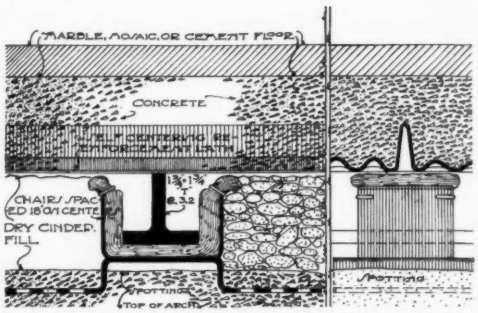


Fig. 9. Detail of Stevens' system of floor deadening on fireproof construction.

Elevator, ventilating, and other machinery should be placed in insulated rooms, on special pads formed of cork, wood, and felt in alternating layers or combinations of Stevens' padded chairs and strips which can be used in sufficient number to carry heavy machines.

Pumps, fans, vacuum pumps, and other machines should be connected to pipes and ducts by flexible rubber, felt or canvas connections, whichever may be the most suitable; these, and felt curtains hung in chambers in connection with large air ducts, will absorb sound which would otherwise be transmitted from the machinery to remote parts of the building.

The electric control of elevators need not be in spaces directly connected to the elevator shaft, but can be placed in insulated chambers at any convenient point, however distant from machine.

Noise caused by electric switches in making and breaking contacts is particularly penetrating, especially during the night when general noises do not prevail.

Elevator shafts should not open on room corridors, but, on a separate hall or entry, inasmuch as the noise caused by the latch of the metal shaft doors and of the elevator is difficult to eliminate.

Latches should be omitted on interior doors and they should be equipped with a good check and spring to close them noiselessly. If so arranged they can be pushed to open in one direction and if suitably shaped hooks are provided on the other side of the doors, they can be opened in the other direction by the forearm, which will permit a nurse to carry a tray or other similar article in both hands.

Corridors are magnified speaking tubes and sound will be reflected from walls, ceiling, and floor, first from one and then from another, losing some little sound at each reflection but usually continuing from end to end. Inasmuch as there are a comparatively small number of people in corridors, no draperies, and almost no pilasters or projections, and as the wall and ceiling surfaces and floors are hard, very little sound is absorbed.

Dividing their length by partitions would help but partitions of ordinary construction would obstruct light and are, therefore, not practical, but conditions can be bettered considerably by placing partitions of light steel and glass at intervals. These do not obstruct light and if the doors are wide, double acting, and the glass well protected by push bars they do not offer much obstruction to travel. Obviously any section of a corridor without windows should be ventilated by mechanical means.

Of all the floors in a hospital, the corridor floors require deadening the most. Not only should they be insulated to prevent the travel of sound to spaces under them but sound caused by walking should be absorbed before it can annoy patients on the same floor. Loose runners of rubber or matting are objectionable for obvious reasons and it is wasteful to cover a good tile or terrazzo floor; it, therefore, seems more advisable to arrange recesses in the hard materials of the same thickness as sound-absorbing materials, such as cork, rubber tile, linoleum, elastic tile, and to cement these solidly to a comparatively inexpensive Portland cement base, or on Nalecod. Borders of hard material are admissible and desirable on account of easy cleansing and attractive appearance.